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THE DEVELOPMENT OF MODERN ROENTGEN-RAY GENERATING APPARATUS

CALDWELL LECTURE 1930*

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SCHENECTADY, NEW YORK

1. INTRODUCTION

2. THE X-RAY TUBE
   - *a.* Its Early Development.
   - *b.* Development of Ductile Tungsten.
   - *c.* The Tungsten Target.
   - *d.* Historical Development of the Hot-cathode Tube.
   - *e.* Heat Removal from Focal Spot.
   - *f.* Focal Spot Shape and Size.
   - *g.* Tubes for very High Voltage Roentgen Therapy.

3. THE HIGH VOLTAGE GENERATING APPARATUS
   - *a.* Early Development.
   - *b.* The Self-rectifying X-ray Tube.
   - *c.* The Kenotron Machine.
   - *d.* The Induction Coil for very High Voltage.

4. PROTECTION FROM ELECTRIC SHOCK, AND THE OIL-IMMERSED TYPE OF EQUIPMENT.

5. PRECISION TIMING IN FAST ROENTGENOGRAPHY.

1. INTRODUCTION

THE memory of Eugene Wilson Caldwell will always serve as an inspiration to those who knew him. It was one of the great privileges of my life to be included in his circle of friends. To think of him always brings to my mind those sterling traits of character which he possessed to such an unusual degree. I think of his indefatigable zeal, his dissatisfaction with his own achievement and his constant striving to better it, his great courage and patience in the face of difficulties and, finally, his unconquerable spirit which refused to yield to the sufferings his early roentgen work had brought upon him.

I feel unworthy to give this Caldwell Lecture, but greatly honored in being asked to do so, for I am mindful not only of the great Caldwell, but also of those distinguished men who have preceded me in the series.

The subject of my lecture this evening is the outgrowth of a suggestion made by Dr. Moore that I talk on the historical development of the hot-cathode tube. I questioned at first whether I could make so old a subject interesting to you, but then I remembered that while the theme

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would be old to some it would be new to others. And then I thought that by broadening the field to include the balance of the x-ray generating outfit, I could add more fresh material.

I will limit myself to the medical field, but will make no attempt to cover the whole of it.

2. THE X-RAY TUBE

a. Its Early Development.

The early x-ray tube of Roentgen (Fig. 1), the Crookes tube, was greatly improved

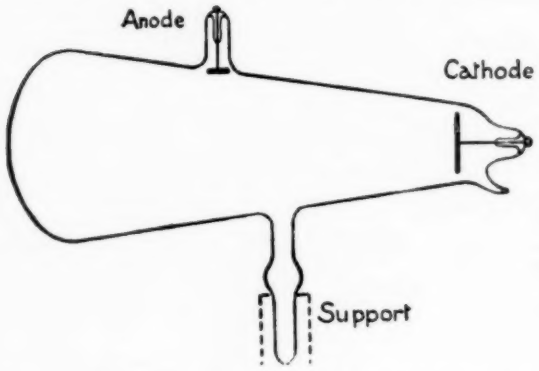


FIG. 1. Early type of x-ray tube used by Roentgen.

by Campbell-Swinton through the introduction of a platinum target and by Jackson, who turned to account a former discovery of Crookes and used a concave cathode (Fig. 2).

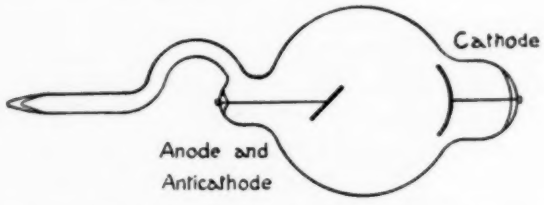


FIG. 2. Jackson's first tube employing focussed cathode rays.

A later step of great importance was the addition of a device for regulating the vacuum of the tube.

For medical diagnostic work, the thin metal target was soon replaced by a heavy mass of metal consisting essentially of two parts, a refractory metal face to take the cathode-ray impact and a heavy backplate consisting of some good heat-conducting metal which would serve to lead away and temporarily store the heat liberated at the focal spot.

Platinum and copper came into very general use for the refractory metal face and backplate, respectively. The platinum facing was made very thin, about 1/1000 inch thick, and was attached to a disk of nickel which, in turn, was soldered to the large mass of copper. The tube had a very definite energy limitation and, if this were exceeded even for an instant, the thin facing of platinum was ruined at the focal spot and the tube had outlived its usefulness.

b. Development of Ductile Tungsten.

In 1905 some developmental incandescent lamp work was started in our laboratory, which led us later into the x-ray tube field. This work began with an investigation of the mechanical properties of metallic tungsten, and resulted first in the production of this element in a ductile form, and finally in its application for various purposes—among others its use for both electrodes of the x-ray tube.

Up to the time when this work was begun, tungsten had always been a brittle metal—as brittle as glass—and not workable. As a result of laboratory efforts extending over several years and involving many men, it became possible to produce metallic tungsten in a form in which it has the strength of steel.

The process which we developed for producing ductile tungsten is unique in this respect, among others, that it does not involve the melting of the metal in a crucible. This has never been feasible, for the reason that there is no suitable material from which the crucible can be made. The fireclays which have been used for crucibles all vaporize at temperatures far below the melting temperature of tungsten.

The process starts with wolframite (an ore consisting of iron, manganese, tungsten, and oxygen) from which the yellow oxide

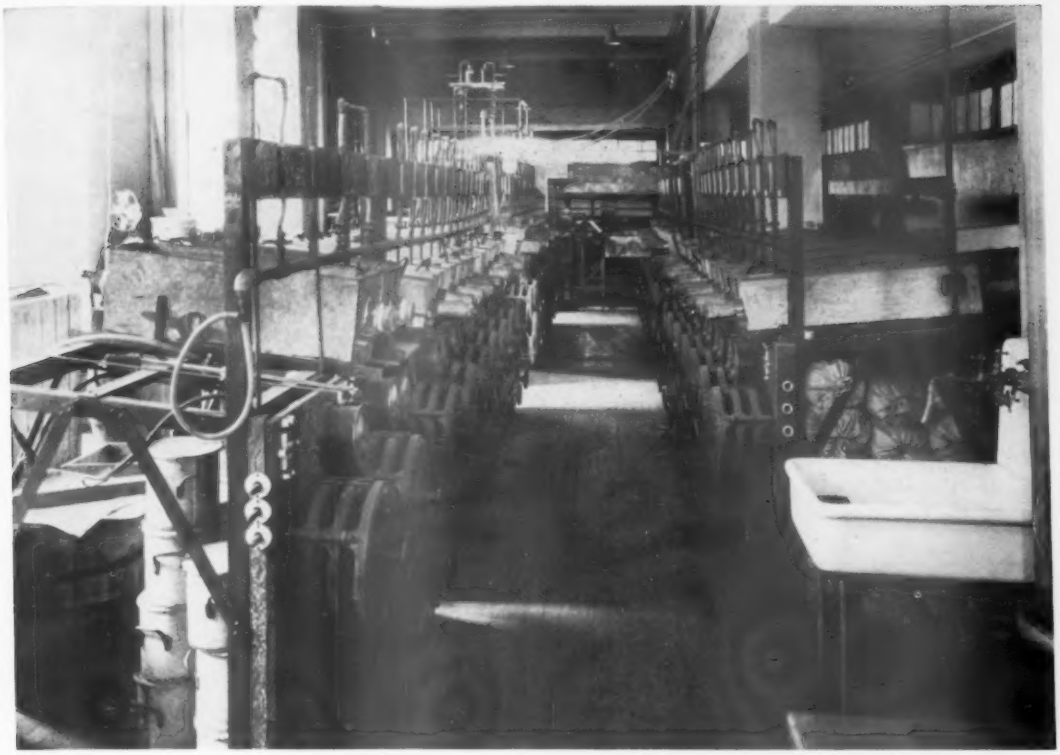


Fig. 3. Battery of electric, hydrogen-atmosphere furnaces for reducing the yellow oxide of tungsten to metallic powder.

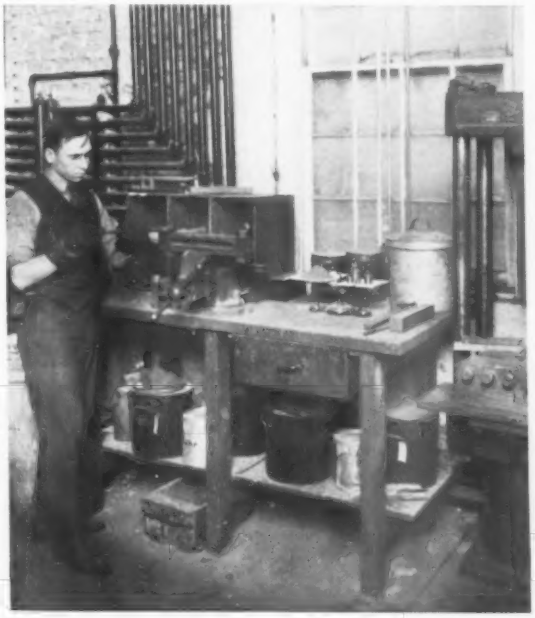


Fig. 4. Compressing the metallic tungsten powder to rod form by means of hydraulic press and steel mold.

Fig. 5. Sintering tungsten rod in hydrogen treating bottle (raised to show rod clamped in position).

of tungsten is extracted and then highly purified.

This yellow oxide is next reduced to metal powder by heating it electrically in a porcelain tube through which a stream of hydrogen gas is passing (Fig. 3). A very careful and exact control of the conditions of the reduction process is necessary, so that the resulting tungsten particles shall have the right size.

The dry tungsten powder is next formed under heavy pressure into rods (Fig. 4), and these are then heated electrically almost to the melting point in hydrogen (Fig. 5). The resulting ingots are brittle cold, but can, with care, be mechanically worked when hot (Fig. 6), and as the mechanical

FIG. 6. Hot swaging the tungsten rod.

working proceeds the individual crystals are elongated into fibers (Fig. 7) and the metal is thereby strengthened. With sufficient working the resulting material becomes ductile cold.

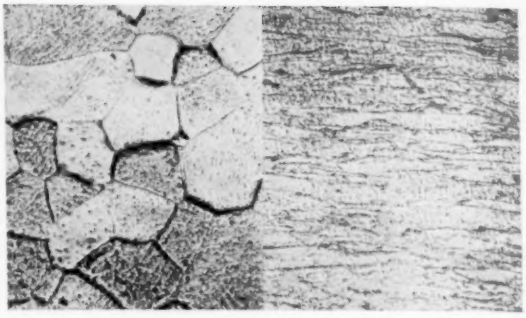


FIG. 7. Photomicrograph of the crystalline structure of tungsten before swaging (left) and the fibrous structure afterward (right).

c. The Tungsten Target.

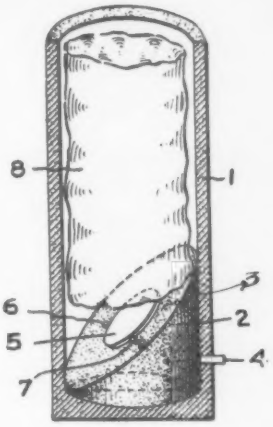
After the ductile tungsten process had been developed sufficiently for the needs of incandescent lamp manufacture, the next application which we found for it was as the target of the gas-filled x-ray tube, in place of the platinum which had previously been used.

For this application, sheet tungsten was required, and it was found that this could be produced by hot-rolling the original rods or, better, those which had first had a certain amount of hot hammering. From such sheets or strips the small disks required were produced by hot-punching (Fig. 8).

Our next problem—and it caused a delay of many months—was to find a method for bringing a disk of tungsten into good heat-conducting relation with the large block of copper forming the balance of the target. There was, at that time, no known means for soldering tungsten to copper or to anything else.

It finally developed that copper could be attached directly to tungsten in the following manner: The surface of the tungsten is first carefully freed from oxide. Copper which has been freed of its oxide by treatment with one of the boron compounds is then cast in a vacuum onto the tungsten. Under these conditions, the copper wets the surface of the tungsten as water wets glass, and the result is a union of very high thermal conductivity

between the two metals. The practical means employed for carrying out the vacuum-casting operation are as follows (Fig. 9): A cylindrical graphite crucible, 1, is made with an inside diameter slightly larger than the desired diameter of the finished target. A removable graphite piece, 2, is made to stand in the bottom of the crucible and to serve as a temporary support, at the desired angle, for the tungsten disk, 5. The latter is kept from sliding down the inclined face of its support by two little molybdenum pins, 6 and 7, which fit in holes in the graphite support. A block of boron-treated copper, 8, is then placed in the crucible. The crucible and its contents are then placed, together with



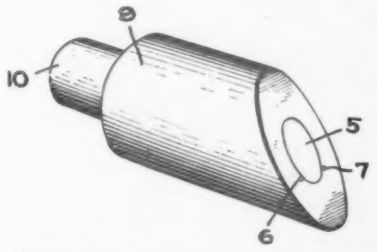


FIG. 9. Means for vacuum-casting of copper around tungsten disk, and the finished copper-backed tungsten target.

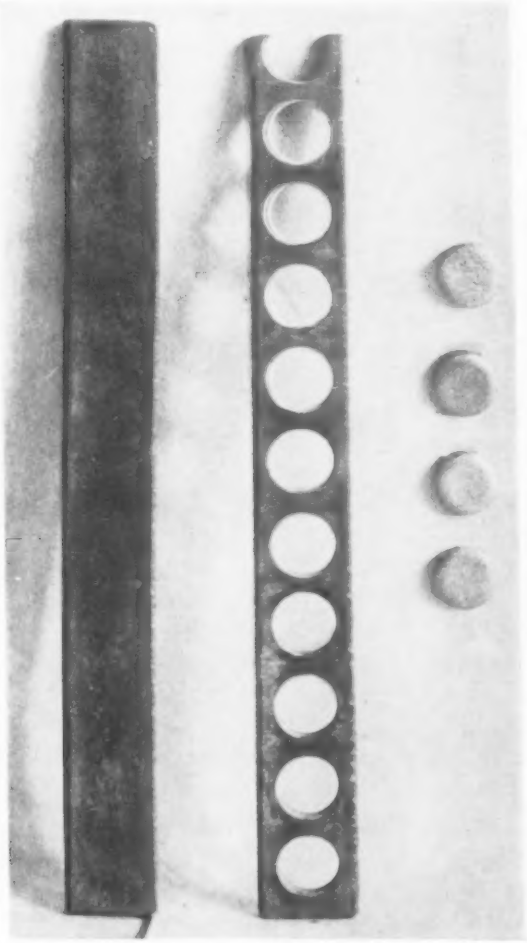


FIG. 8. Steps in the production of the tungsten disks for x-ray targets.

others, in an electrically heated vacuum furnace and the temperature is raised slightly above the melting point of the copper. The temperature must not be too high, as otherwise the strength which has been produced in the tungsten by the mechanical working will be lost and the target will crack badly in use.

The tungsten disk must not be too thin, for otherwise copper will melt back of the focal spot and will, by its expansion, cause a bulging out of the tungsten at this point. Upon cooling, the copper will contract, leaving a vacuous space immediately under the tungsten at the focal spot; the target is then ruined, as the good heat conductivity between the tungsten and the copper at the focal spot has been lost. As copper conducts heat better than tungsten, it is,

on the other hand, better to have the tungsten disk no thicker than is necessary to avoid the melting of the copper under the focal spot.

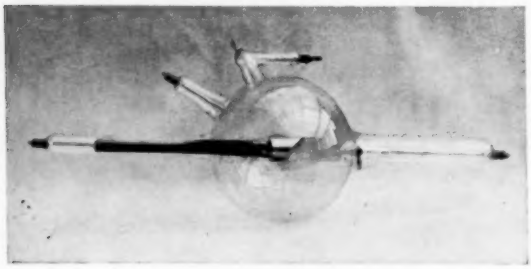


FIG. 10. Gas tube employing copper-backed tungsten target.

The advantages of ductile tungsten over platinum for the target face are its higher melting point, lower vapor pressure, and greater heat conductivity. Its use resulted in better definition in diagnostic work because it made possible the production of much higher x-ray intensities from a given size of focal spot.

Trial targets consisting entirely of tungsten were also made for the gas tube, and, in competition with those of solid platinum, they also looked very attractive as they were capable of radiating from a given surface area, much greater amounts of energy.

Before the advent of the hot-cathode tube, the tungsten target (Fig. 10) had replaced the platinum target almost completely in the high power roentgenographic tubes made in this country.

d. Historical Development of the Hot-Cathode Tube.

The development work on the copper-backed tungsten target brought with it interesting experiences with gas-filled x-ray tubes that had been built to enable us to test out different constructions and designs of target. Large amounts of energy were passed through these tubes to show which kind of target best withstood abuse. Upon overloading the focal spot, tungsten vapor was produced and this tungsten vapor brought about very rapid changes in gas pressure. These pressure changes are now easily explainable. Dr. Langmuir[1] has found that tungsten vapor unites quantitatively with nitrogen; hence any nitrogen gas was removed as such and deposited as solid nitride on the walls of the tube. Oxygen reacted with hot tungsten to form a solid oxide of tungsten which was also deposited on the bulb. Hydrogen, argon and helium were tried but it was found that, in time, they also disappear from the space. These gases which do not react with hot tungsten or with tungsten vapor are probably, in part, shot into the glass and, in part, trapped under the tungsten which deposits rapidly on the surface of the bulb when the tube is overloaded.

Upon overloading the tubes, the glass around the cathode became very hot and frequently cracked. This was finally prevented by immersing the tubes completely in oil.

Another trouble then made its appearance. The aluminum cathodes melted. To obviate this, a solid tungsten cathode was tried. This made the tube exceedingly "cranky." One would no sooner get it started than it would refuse to carry current until more gas had been introduced from the regulator.

The extreme instability attendant upon the use of a cold tungsten cathode in what was otherwise a standard x-ray tube, called attention forcibly to the part played by the gas in the ordinary aluminum cathode. (The tungsten cathodes were relatively very free from gas.)

The need of gas in the aluminum cathode had been well recognized, and, as far back as Dec. 6, 1899, we find a note by Rollins referring to a tube having an aluminum cathode which had been intentionally deprived of its usual hydrogen gas content. He says, "Such a tube could rest until doomsday and not make the faintest spark in the universal gloom."

In considering the various troubles ex-

[1] *J. Am. Chem. Soc.*, 1915, *35*, 943.

perienced in the operation of these tubes, one thing was clear, namely, that they all came from the gas in the tube and the positive ion bombardment that took place when that gas was present. It was clearly desirable to get rid of the gas, but it was then imperative to have some other mechanism for getting electrons out of the cathode.

Edison, in his work on the incandescent lamp, had shown that in the vacuum of the lamp, current could be made to flow from the hot filament to an anode. Much additional light had been shed on this phenomenon by the work of Richardson[2] and others. Richardson had investigated the law connecting the electron emission with the temperature of the hot body. The values of the currents obtained from hot cathodes by different observers had varied between such wide limits, however, as to suggest that an x-ray tube based upon this principle might be as unstable as the regular gas tube. Furthermore, some investigators had come to the belief that the whole hot cathode effect was due to gas contained in the cathode itself and that no current would flow from a hot cathode which had been completely freed from gas.

This was the state of affairs when Langmuir,[3] in our laboratory, took up the study of the electron emission from hot tungsten filaments. He found that the electron emission not only persisted in high vacua, but was favored by getting rid of the last traces of the tube. In this way, he was able to realize conditions which were stable and reproducible.

The same method was tried with the x-ray tube, and we found that here also, even with the much higher voltages and the much larger masses of metal, we were able to get and to maintain vacua in which the phenomena were stable and reproducible.[4]

The idea of using a hot cathode in an x-ray tube was not new, but the principle had never been successfully applied in a vacuum so good that positive ions did not play either an essential or a harmful role.

The hot-cathode tube of Wehnelt and Trenkle[5] employed a lime-coated hot-cathode as a main electrode, but the vacuum employed was too poor to permit of operation with more than about 1000 volts, as otherwise the positive ion bombardment removed the electron-emitting lime coating from the cathode.

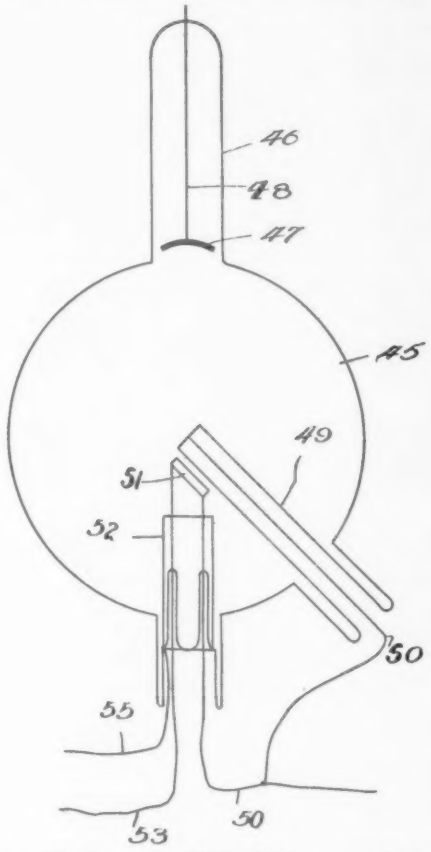


Fig. 11. Early type of Lilienfeld x-ray tube.

In the early hot-cathode tube of Lilienfeld[6] (Fig. 11) the main electrodes, 47 and 49, were exactly the same as in the ordinary gas tube. By means of current flowing between a pair of auxiliary electrodes, 51 and 52, the cathode of which, 51, was heated, the gas content of the tube was

[2] *Proc. Camb. Phil. Soc.*, 1902, *11*, 286.
[3] *Proc. Roy. Soc.*, 1903, *71*, 415–418.
[4] *Phys. Rev.*, 1913, *2*, 409–430.
[5] *Sitzungsb. d. phys.-med. Soc. zu Erlangen*, 1905, *37*, 312–315.
[6] Lilienfeld, J. E., and W. J. Rosenthal, W. J. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1912, *18*, 256–263.

ionized, and, by varying the discharge current passing between the auxiliary electrodes, the conductivity of the tube could be controlled. The tube operated with a somewhat lower gas pressure than that of the ordinary gas tube. It was still a gas tube, however, and could not be operated if the pressure became too low.

In the first of our tubes, the cathode consisted of a spiral tungsten filament mounted behind a centrally perforated tungsten or molybdenum focussing disk, both filament and disk being set in the cathode side-arm and the anode consisted of a circular tungsten disk attached to the end of a tungsten support-rod (Fig. 12).

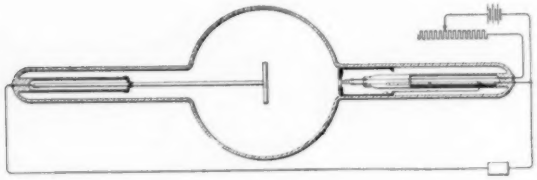


FIG. 12. Diagram of early type of hot-cathode x-ray tube with spiral tungsten-filament cathode set behind focussing ring, and circular tungsten-disk anode, together with the high-voltage and filament-heating circuits.

From the earliest form, the design changed, before the tube went on the market, to essentially that of the present "Universal" type (Fig. 13).

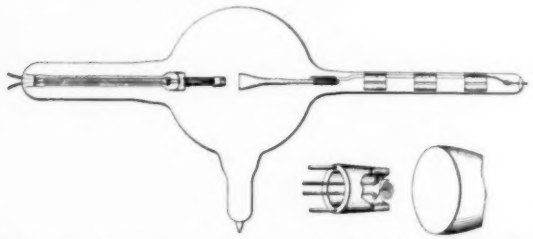


FIG. 13. Later form of hot-cathode tube having the principal features of the present-day "Universal" type.

You are all familiar with the various forms which have appeared since then, both in this country and abroad.

Experience has shown that the main advantages of the hot-cathode tube over the gas tube are the following:

Flexibility.

Stability, permitting more accurate reproducibility of results.

It can be made much smaller.

It can be operated directly from a transformer, making possible a very simple type of outfit.

Long life.

e. Heat Removal from Focal Spot.

There are only two ways in which appreciable heat removal from the focal area can take place: by direct radiation from the focal spot and by conduction away from the focal spot to other parts of the target from which it can later escape in various ways. The limiting case is that in which the entire focal area is brought to the melting point (if one attempts to go higher than this, the appreciable vaporization of the tungsten leads to great instability in the discharge). With the focal spot at the melting point, the direct radiation amounts to only 3.6 watts per square millimeter. In a tube, then, operating, for example, at 100 milliamperes and 85 kv. (peak) and having a focal area of 17 sq. mm. only about 60 watts, or 1 per cent of the total energy input, would be radiated directly from the focal spot. The large bulk of the energy must then be conducted away from the focal area through the adjacent metal.

The superiority of a copper-backed target to one of solid tungsten for diagnostic work is due to the fact that copper has much greater heat conductivity than tungsten.

Having got the heat away from the immediate neighborhood of the focal spot, there are various ways of removing it from the head of the target.

In copper-backed tungsten targets, the heat flows through the large copper stem to the radiator outside.

Heat removal may, in general, be further expedited by the use of water. This seems especially desirable in the case of high power therapy tubes.

Where the tube is operated in oil, the

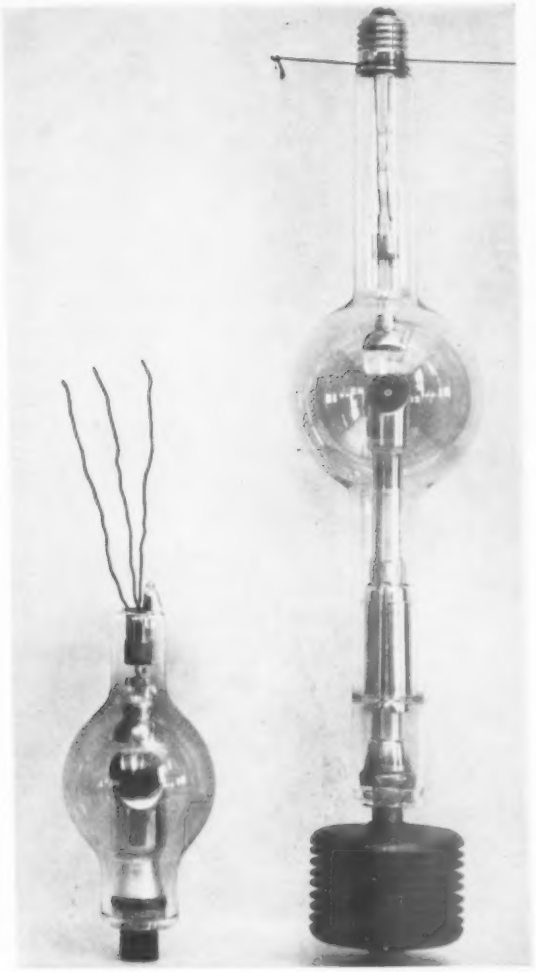


Fig. 14. Air-cooled and oil-immersion types of x-ray tube designed for 30 ma. and 85 kv. (peak), the latter capable of continuous operation at this load 8 times as long as the former.

length of the anode stem may be greatly reduced from that required for operation in air, and, in this way, heat removal may be facilitated. This is illustrated by the two tubes shown in Figure 14, the longer of which can be operated continuously in air at 30 ma. and 85 kv. (peak) for only thirty seconds while the shorter one can be run in oil at the same current and voltage for four minutes.

The neck of the bottle in the cooling process in the diagnostic tube is the resistance, to heat flow, of the metal in the immediate neighborhood of the focal spot.

There are two methods which can be used to minimize the effect of this limitation.

The first consists in changing from single phase to multiphase current excitation, or better still, to direct current at constant potential. The main advantage derived from this method is due to the fact that it does not involve the high peak values of current required to give the same milliamperage on single phase current. It is these peak values which set the limit in the latter case. The only trouble with this method is that, except in those rare cases where multiphase current is already available in the medical roentgen laboratory, it involves a very considerable increase in the cost of equipment.

The second method consists in the use of a lateral movement of the target face with respect to the cathode rays. This method was advocated by Dr. Elihu Thomson in a patent applied for in 1914 in which he proposed to rotate the target by the

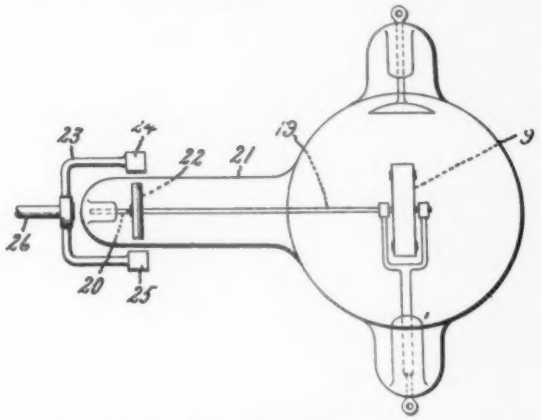


Fig. 15. X-ray tube with rotating target, by Thomson.

help of an electric motor (Fig. 15). I[7] have used this method (Fig. 16), and a tube of

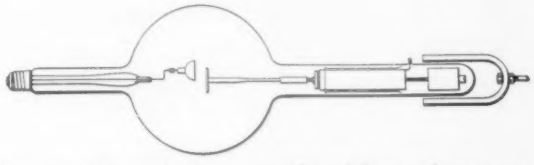


Fig. 16. Hot-cathode x-ray tube with rotating target.

[7] Am. J. Roentgenol., 1915, *2*, 884–885.

this type has been described by Bouwers.[8] I have accomplished the same result by rotating the entire tube (Fig. 17), while holding the cathode-ray stream stationary

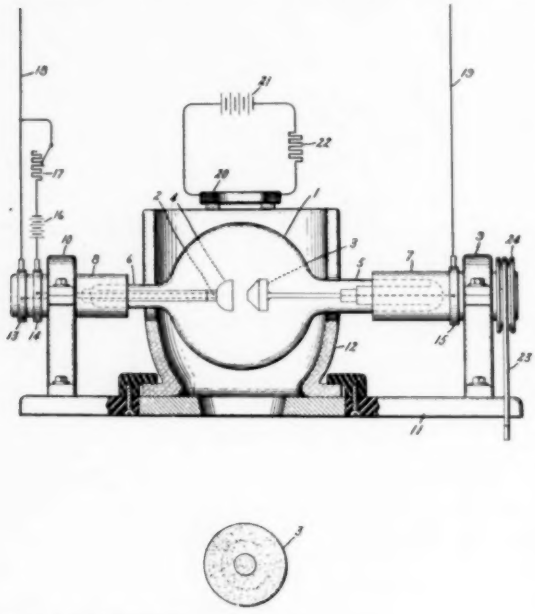


FIG. 17. Rotating x-ray tube.

in space and bent away from the axis of the tube by means of a solenoid, 20, or a small magnet. Rotation of the entire tube has the advantage over rotation of the anode only, in that it does away with the lubricating difficulties attendant upon the use of internal bearings. It also makes easier the removal of heat from the anode by permitting the use of the ordinary solid copper anode stem leading out to a radiator, and even facilitates the action of the latter by rotating it in the air.

By rotation of either tube or target, the allowable energy input per unit area of focal spot can be increased several fold. The future of such a system simply awaits the answer to the question as to whether the gain justifies the complications and limitations involved.

f. Focal Spot Shape and Size.

In tubes having a target angle of 45°, the focal spot is elliptical, the longer dimension being about 40 per cent greater than the shorter one. When viewed in the direction of the normal to the target face, the focal spot is seen in its true elliptical shape; in the direction of the so-called "central ray," as a circle; and, in the direction of glancing incidence, as a line.

The significance of this change in apparent shape with direction, was recognized by Rollins who, in 1897, published a note on "Why the definition of a reflecting focus X-light tube is better in one plane than another," and said: "In practical work we should be careful to place the tube in such relation to the patient as to see the oval figure at an angle to reduce its length."

The fact that the focal spot appears different in different directions leads unavoidably to a certain astigmatism in the roentgenogram, and this effect increases with ellipticity. If, however, the user will limit himself to a sufficiently narrow cone of rays, taken in the right direction, he can gain considerably by using an elliptical focal spot. The gain consists in an increase in the x-ray intensity per unit of apparent focal area. There is a limit to the ellipticity which can be helpfully employed, for, if it is too great, the rays will have to be taken off at almost glancing incidence, and x-ray intensity falls off rapidly as one approaches close to glancing incidence, especially so if any considerable roughening of the focal area has taken place.

In the line-focus tube, as made by the Philips Company,[9] the ratio of length to breadth is about 3 or 4 to 1.

Regardless of the shape of focal spot, for best diagnostic results, the size of focal spot should always be as small as can be used safely with the load.

This can be accomplished crudely by having a number of tubes with a variety of focal spot sizes.

The "Dofok" tube with its two filaments, gives a choice in the one tube, of two different focal spot sizes, and is therefore a step in this direction.

[8] *Verhandl. d. deutsch. Röntg.-Gesellsch.*, 1929, *20*, 103–106.

[9] Goetze, Otto. U. S. Pat. No. 1,590,971.

The method which would accomplish the result most fully would be that, suggested by Dr. Langmuir,[10] in which the focal spot may be given at will any desired size, the adjustment being obtained instantly by varying the potential of the focussing member of the cathode with respect to the electron emitting portion. The only objection to thus giving the operator easy control of focal spot size lies in the fact that it complicates matters for him, forcing him to guard constantly against overloading the focal spot.

It would be more ideal if the focal spot size could be *automatically* adjusted to the load. Two methods of automatically adjusting focal spot size to *milliamperage* have been suggested, one by Franke[11] and the other by Kearsley.[12] It would be still more ideal if the adjustment could be to *watts* instead of milliamperage. To be perfect, however, the automatic adjustment for watts should take into account the time factor also, for the shorter the time, the smaller the focal spot which can be used for a given wattage. By further complication, this result also could be accomplished.

The desirability of simplicity in technique may lead one away from the most ideal condition, however, and experience alone will show just how far it is desirable to go in this matter.

g. Tubes for Very High Voltage Roentgen Therapy

For this purpose, use can be made of cathode-ray tube development,[13] in which it has been shown that tubes can be built for very high voltages by the use of a cascade system. By this method there appears to be no limit to the voltage which can be used.

A two-section x-ray tube of this type has been made to operate very satisfactorily on the pump at 3 ma., and 500,000 volts (Fig. 18). The target is placed, not in the center of the bulb, but inside of the copper shield and near the outer end of the anode arm. In this way most of the reflected electrons are kept from returning to the bulb of the second section and getting into the anode arm. With this tube the x-rays are taken out sideways through a hole in the copper shield and through the glass of the anode arm.

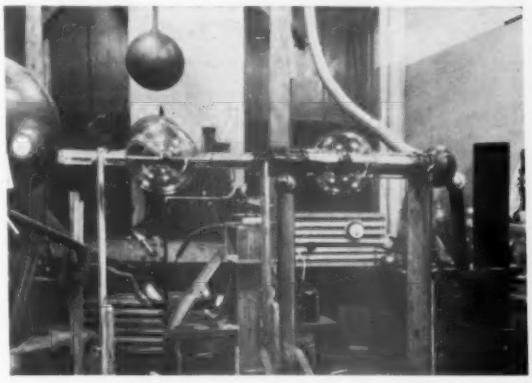


Fig. 18. A 500,000 volt x-ray tube built in two sections.

The outfit shown in Figure 18 has been sent to Cornell University where Dr. Richtmyer will make a study of the radiations emitted.

For trial therapy a three-section tube is being developed for 900,000 volts, to be operated with the anode grounded. In this case the anode will be made thin and the x-rays will be taken out through it, and through the cooling water, in the direction of the axis of the tube.

3. The High-Voltage Generating Apparatus

a. Early Development.

The early sources of current, used to operate the x-ray tube, were the induction coil, the static machine and the high frequency coil.

A great stride forward was taken by Snook who developed the Lemp Selector into a very satisfactory high-power source of rectified current.

[10] U. S. Patent No. 1,251,388.
[11] *Brit. J. Radiol.*, 1927, *23*, 134–139.
[12] Am. J. Roentgenol. & Rad. Therapy, 1930, *23*, 170–172.
[13] Coolidge, W. D., Am. J. Roentgenol. & Rad. Therapy, 1928, *19*, 313–321.

b. The Self-rectifying X-ray Tube.

The hot-cathode radiator type of tube made possible the very simple type of equipment in which the tube operates directly from the transformer.

The question will be asked as to why a rectifier of any kind should ever be used in series with a self-rectifying x-ray tube for such loads as the latter can by itself safely rectify. There are two reasons for it. In the first place, the focal spot can be made appreciably smaller if the x-ray tube is not required to act as a rectifier. In the second place, an x-ray tube may, by abuse, be brought into such a condition that it will not operate satisfactorily on unrectified current but will still operate in a perfectly satisfactory manner with a rectifier.

In the past it has not seemed practical to operate any half-wave outfit with very high milliamperage owing to the fact that the inverse voltage becomes so high. A recent invention of Kearsley's[14] has, however, greatly changed this. By the simple introduction of a mercury arc or other rectifier in series with the primary of the x-ray transformer (Fig. 19) he has increased by several fold the allowable output from a given half-wave outfit.

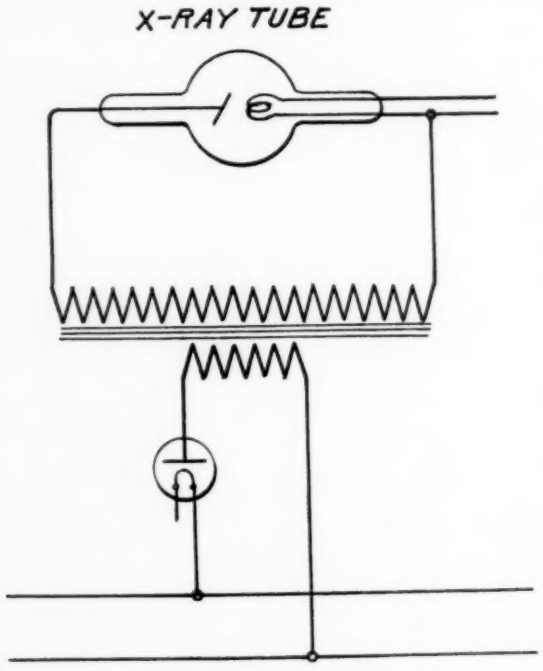


FIG. 19. Diagram of x-ray generator circuit with rectifier in primary to reduce inverse voltage.

[14] *General Electric Review*, 1930, *33*, 572.

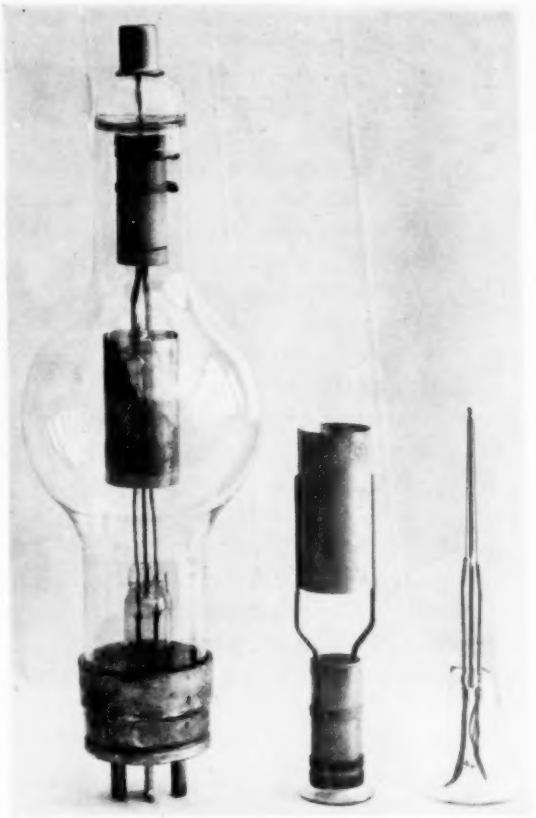


FIG. 20. Early form of kenotron tube and its component parts.

c. The Kenotron Machine.

The kenotron tube was first described by Dr. Dushman, of our laboratory, in 1915. From the beginning, it has offered a number of advantages over the mechanical rectifier, which are so obvious that one may easily wonder why it did not immediately replace the latter in all x-ray generating equipment. The answer is simply that the mechanical rectifier was at that time a highly developed tool and the kenotron tube (Fig. 20) had not been developed to a point where it seemed that it could compete with it in the x-ray field

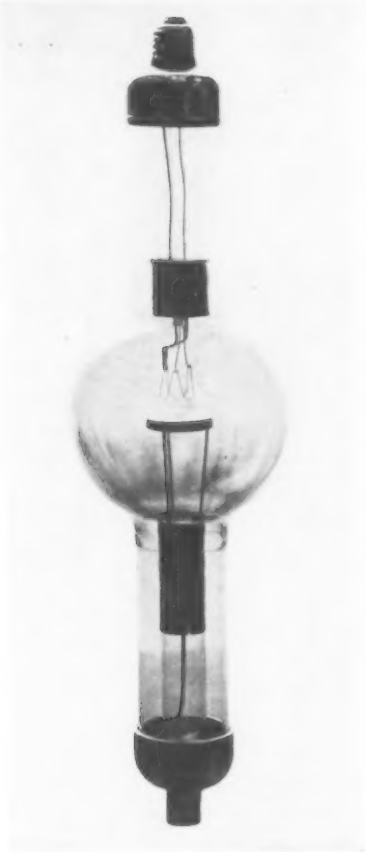


Fig. 21. Form of kenotron tube which has been used in most x-ray generator circuits.

in point of reliability. In a later form of kenotron tube (Fig. 21) which has been used in many x-ray outfits, there has been a variable charging up of the inner surface of the glass. This has been described by Max Wellauer.[15] As a result of this trouble the voltage drop in this type of kenotron tube was a variable quantity, depending on the vacuum. It might be 500 volts or, an instant later, it might be 5000 volts. As, with the bridge connection (full wave rectification) there were two kenotron tubes in series, this introduced an uncertainty of several thousand volts in the voltage supplied to the x-ray tube and was therefore opposed to the exact duplication of roentgenographic results. In still later forms the anode is, as at first, made to surround the cathode, thus eliminating the instability.

It has been shown that the x-ray output per milliampere is the same from a kenotron machine as from a properly adjusted mechanical rectifier and higher than from an improperly adjusted one.

There is no valid objection to the idea of a kenotron machine, and the future of this type of equipment will depend entirely upon the satisfactoriness of the kenotron tube itself and upon apparatus design features calculated to minimize as much as possible the needless demands made upon the kenotron tube.

By the use of a multiplicity of kenotron tubes on multiphase current, or with kenotron tubes and condensers, voltage fluctuations at the tube terminals may be reduced to any desired extent, that is, one may approach as closely as he desires to constant potential continuous current.

d. The Induction Coil for Very High Voltage.

For the production of very high voltage radiation, we have developed a type of induction coil which is relatively cheap and easy to make and very satisfactory (Fig. 22). We started with the idea of using solid dielectric between the primary and secondary, but have found it much

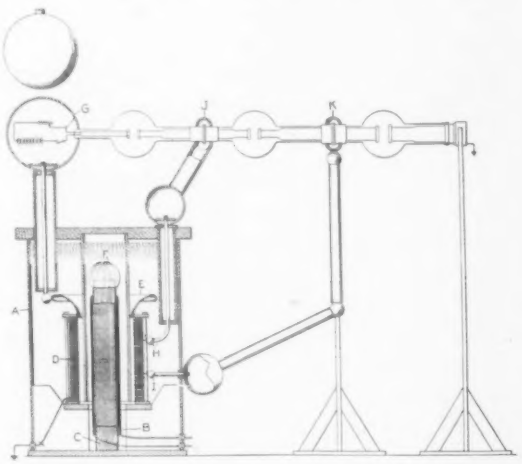


Fig. 22. Diagram of induction coil for supplying 900,000 volts to operate a multisection x-ray tube.

[15] *Arch. f. Elektrotechnik*, 1926, *16*, 13–27.

better to rely mainly on oil. The container *A* is a "herkolite" (paper-resin) tank. The primary *B* is a helical coil wound on an insulating tube that surrounds the core *C*. The secondary *D* consists of thin coils placed one on top of the other with paper rings between. The lower end of the secondary is grounded, and the potential difference between secondary and primary then increases as we come up, reaching its maximum at the top of the secondary. Arc-over would take place from the top of the secondary to the primary at about 600,000 volts, were it not for the split aluminum spinning *E*, which electrostatically shields the upper end of the coil and makes it possible to go to about 800,000 volts. At this point, arc-over would take place from the aluminum spinning to the upper end of the core were it not for the spherical shield *F*, which makes it possible to go up to 900,000 volts. The design of the shield *F* is important as it has to be electrically conducting and is located where nearly all of the magnetic flux of the core passes through it. If it were a hollow metal sphere of appreciable thickness, most of the energy delivered to the primary would be wasted in the sphere in eddy currents. The construction indicated has been found satisfactory and consists of a wooden sphere overlaid with narrow strips of sheet aluminum placed as shown, and metallically joined at the top and connected to the upper end of the core.

The 900,000 volt lead from *E* passes up through an oil bushing to a 20″ hollow metal sphere *G*, consisting of two separable hemispheres, which serves as a container for the storage battery used to light the filament and, at the same time, as a terminal of the measuring sphere gap. To secure other potentials for the intermediate electrodes of a three-section tube, the 600,000 and 300,000 volt taps, *H* and *I*, are brought out to the intermediate electrodes of the tube, *J* and *K* respectively.

The coil is operated from 1200 volt, 60 cycle current, by means of a hydrogen-filled mercury turbine interrupter driven from a synchronous motor. Such an outfit is to be installed shortly, for experimental therapy, at the Memorial Hospital in New York.

As one end of the secondary is grounded, it will doubtless be possible to operate two such coils in series to produce 1,800,000 volts. It seems, furthermore, as though larger coils could be built in this way for much higher voltages.

It may seem like turning the clock backwards to be working on induction coil developments at this time, and that it would be better to use transformers with kenotron tubes and condensers. For the medical applications, however, it seems as though very little current would be required at these high voltages, and, if this is true, the induction coil seems to be especially suited to the purpose, and for the following reasons: In the first place, there is no need of any auxiliary rectifying device, as the x-ray tube is capable of rectifying its own current. The induction coil gives such an unsymmetrical wave that, even with resistance control, the "useful" voltage will be higher than the "inverse," and, as a result, and without the need of any complications, the sphere gap will indicate the "useful" voltage. Furthermore, owing to the simplicity of the high tension circuit the corona loss can be made negligible. The high magnetic leakage, inherent in the straight open core, and the resistance control, both tend to greatly diminish the electrical hazard; they also make it unnecessary to use resistances in series with the measuring sphere-gap.

4. PROTECTION FROM ELECTRIC SHOCK, AND THE OIL-IMMERSED TYPE OF EQUIPMENT

The hot-cathode tube has brought, in its train, for roentgenographic work, autotransformer control. This has tremendously increased the danger from accidental contact with the high tension circuit. Even with resistance control, however, the danger would still be very great when using high milliamperage. For these reasons more

attention must be given to the matter of electrical protection.

For diagnostic work, the outfit in which the x-ray tube and the entire high tension circuit are immersed in oil in a grounded metal container, promises to become the final type of x-ray generating equipment, for the following reasons:

1. It completely eliminates the electrical hazard.

2. By permitting a great reduction in the length of the anode arm of the tube, and, hence, the anode stem, it gives a corresponding increase in the rapidity of heat removal from the anode, thus allowing increased x-ray output in a given time.

3. It eliminates the effect of altitude and humidity.

4. It eliminates fire-risk in the presence of ether vapor.

5. It gives mechanical protection to the x-ray tube and insures the mechanical integrity of the entire high tension circuit.

For mechanical reasons, it is desirable that the weight and bulk of the head of an oil-immersed outfit should be kept as low as possible. If the movable part were too heavy, its inertia would be troublesome, making it too laborious, even in the absence of all friction, to produce the acceleration and deceleration involved in moving it quickly from one position to another in space. These conditions have seemed to favor half-wave operation, and this, because of the "inverse" problem, has limited the capacity of such outfits. Kearsley has recently found, however, as has already been mentioned, that with half-wave operation, "inverse" can be greatly reduced by the use of a mercury arc or other rectifier in series with the low voltage primary circuit. In this way a several fold increase in capacity may be made without increase in size and in fact without any change in the movable member.

5. PRECISION TIMING IN FAST ROENTGENOGRAPHY

Generally speaking, it seems questionable whether very high speed roentgenographic work has, in the past, been satisfactory. The reason for this is to be found in the fact that with increase in speed there has in general been a decrease in the precision of the work. In other words, it has not been possible to duplicate results as closely. This is partly due to imperfections in the timing device itself but, more especially, to the fact that the time taken in actually opening the circuit was so variable depending on whether it happened that the event was scheduled to take place at zero, or at the peak, or at some intermediate point in the voltage wave.

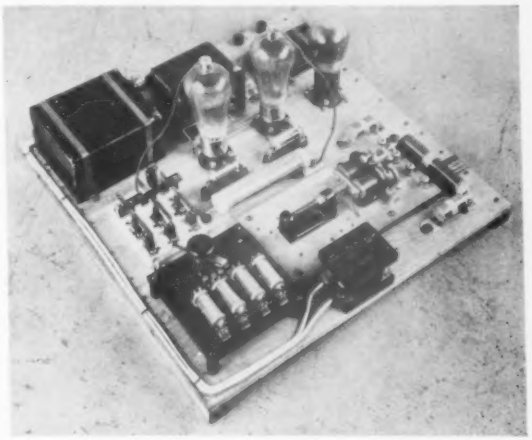


Fig. 23. Kearsley vacuum-tube time switch. Upper left: Condenser. Lower left: Adjustable rheostat. Upper right: Thyratron tubes. Lower right: Relay.

To get precision timing for high speed work, it is desirable to make and break the primary circuit at zero on the voltage wave. This result has been accomplished in two ways by Kearsley.[16]

One of these is a vacuum tube time switch, with no moving parts, consisting essentially of a condenser which is first charged to a definite potential and then discharged through an adjustable rheostat. When the condenser voltage has dropped to a certain value, in a time determined by the value of the resistance used, the x-ray circuit is opened through the control of the potential of a grid in a small thyratron

[16] To be published in the *General Electric Review*.

tube. Where a relay is not objectionable, one may be added to the output circuit of the vacuum-tube time switch for special applications (Fig. 23).

Another one is a synchronous motor driven time switch (Fig. 24), which is so designed that the exposure may be started on zero, and then, through grid control with thyratrons or pliotrons, stopped on zero after the desired number of current impulses.

This form of time switch is particularly noteworthy for its high precision which is obtained through the use of the synchronous motor and a positive gear drive from the motor to the contacts.

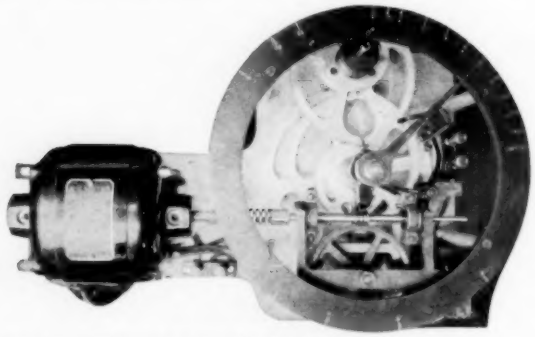


FIG. 24. Kearsley mechanical time switch.

The switch is so designed as to have a tapered scale with widely spaced divisions below one second thus giving equal precision in setting throughout the whole twenty-five second range. This makes accurate setting easier, and there is much less chance of error than where a double scale and selector switch are employed.

An unusual feature of this switch is that the motor does not operate continuously but starts an instant before the exposure is to be made and stops when the control switch is released. This not only insures quietness when not in actual use but greatly reduces wear, and simplifies lubrication problems.

In the preceding I have attempted to emphasize some of the fundamental principles involved, in order to show why x-ray generating apparatus has its present limitations and to indicate in a few cases how the capabilities of the apparatus may be increased in the future.

Vol. XXIV, No. 6

THE SYMPHYSIS PUBIS IN THE ROENTGEN EXAMINATION OF THE SACROILIAC JOINT*

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THE somewhat controversial subject of "sacroiliac slip" appears to owe its modern origin to Goldthwait and Osgood, who published in 1905 a most important contribution to this subject. Their paper entitled, "A Consideration of the Pelvic Articulations from an Anatomical, Pathological and Clinical Standpoint"[2] serves very well as a starting point for a modern study of this subject. In passing, however, it is interesting to follow Goldthwait and Osgood and go back a bit further to the paper of Snelling, published in 1870, entitled "Relaxation of the Pelvic Symphyses during Pregnancy and Parturition."[4] According to Snelling, observations of this condition date back to the time of Hippocrates.

The work of Goldthwait and Osgood included a thorough report of the literature, but they were unable to find any allusion to such affections of the pelvic joints apart from pregnancy. Their own work began with a consideration of these joints in connection with pregnancy. They later convinced themselves that certain cases occur, in the absence of pregnancy, in connection with menstruation, and finally they successfully applied the same considerations to explain certain cases of low back and leg pain and disability, occurring both in men and in women.

Since the first report of Goldthwait and Osgood, much has been written upon this subject. Apparently the medical profession greeted enthusiastically this possible explanation for a large group of low back conditions, in which both diagnosis and treatment had been unsatisfactory. The diagnosis "sacroiliac slip" came into vogue, with the almost unanimous consent of the orthopedists as well as the rest of the profession.

There has since been some reaction, so that today there are many physicians who either doubt the existence of such a thing as sacroiliac slip in any important number of patients, or frankly believe that such displacements are anatomically impossible. Roentgenologists have been particularly active in throwing doubt upon the existence of displacements of the sacroiliac joints, apart from the occasional gross dislocations in connection with severe injuries. The point of view of Baetjer and Waters may be taken as more or less typical. In their text, "Injuries and Diseases of the Bones and Joints," 1921, written from the roentgenological viewpoint, they dismiss the whole subject of sacroiliac displacement or slip, in the following words: "The so-called sacroiliac subluxations, in the writers' opinion, do not exist. The joint is of the saw-tooth variety and before a slipping could take place these saw tooth edges would have to be broken. These conditions must be ligamentous sprains."

Perhaps the tendency for roentgenologists to discredit the diagnosis of sacroiliac slip springs from repeated failure to demonstrate such displacements upon the roentgenogram even where the cases are clinically typical.

In 1919, Dr. Thomas A. Stoddard of San Francisco, called my attention to the fact that while the usual roentgen examination of the sacroiliac joints could be expected to show a considerable displacement in a longitudinal direction, displacements in a dorsoventral direction would be difficult to identify upon a roentgenogram, and rotatory displacements about a trans-

* Read at the Twenty-third Annual Meeting, American Roentgen Ray Society, Los Angeles, Sept. 12–16, 1922. Presented in summary at the Fifty-eighth Annual Meeting, California Medical Association, Coronado, May 6–9, 1929.

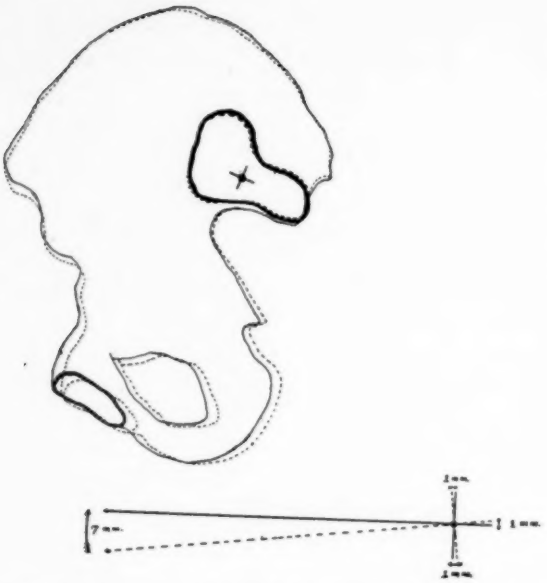

FIG. 1. Diagram of medial aspect of innominate bone. When sacroiliac joint motion occurs, it is rotatory, with axis of rotation within the joint. The pubis exhibits an excursion which is magnified in proportion to its distance from the axis of rotation.

FIG. 2. This patient (see also Fig. 7) was suffering from a sacroiliac subluxation and relaxation. The roentgen appearance of the sacroiliac joints themselves is not remarkable. But the left pubis is higher than the right, and there is an increase in the spacing between the pubes.

verse axis would, in all probability, never become apparent upon such roentgenograms. This idea resulted in a change in technique so that for the past ten years all roentgenograms of the sacroiliac region have been made so as to include the symphysis pubis and entire pelvic brim in one stereoscopic examination. The result has been a most gratifying roentgen corroboration of the clinical concepts of Goldthwait and Osgood, and it is interesting to note that in their original paper they pointed out that motion in the sacroiliac joint, when it occurs, is rotatory about a transverse axis normal to the articular surfaces.

FIG. 3. Photograph of patient in position for one of the special anterior projections of the symphysis pubis. Note Potter-Bucky diaphragm, and 3 inch steps, one of which has been removed from under the left foot, leaving weight on the right leg.

For the purpose of the roentgen study of the sacroiliac joint, let us conceive of the pelvic arch as the long arm of a kymographic recorder, and the symphysis as its point, describing during any rotatory

sacroiliac displacement, a magnified stroke (see Fig. 1). This excursion of the pubis will be capable of demonstration upon the roentgenogram unless an exactly equal and symmetrical displacement in the other sacroiliac has resulted in both pubes rising or falling to the same extent. Naturally such an exactly equal and symmetrical displacement in the two sacroiliacs would hardly be the rule, so that we can expect to find in a majority of cases of sacroiliac displacement a difference in elevation of the pubes and an asymmetry of the pelvis (see Fig. 2).

Shortly after our discovery that sacroiliac joint motion could be thus demonstrated at the symphysis pubis, we developed a technique for detecting and measuring the degree of movements of these joints with alternation of weight-bearing from one leg to the other. The patient stands on a pair of steps or blocks, 3 inches high, facing a vertically disposed Potter-Bucky diaphragm. With a properly centered beam and an 8″×10″ film, an anterior projection of the symphysis is obtained after the step has been removed from under the left foot (see Fig. 3). The lead marker, reading right, is placed on the right side. In the second picture, with weight bearing on the left leg, the marker, reading left, is placed on the left side.

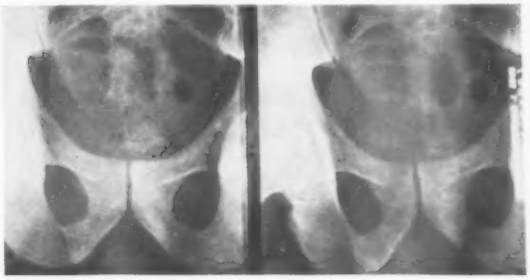

Fig. 4. The special anterior projections in a normal male. Usually there is no measurable displacement in the normal male, but motion up to 0.5 mm. at the pubis is considered within normal limits.

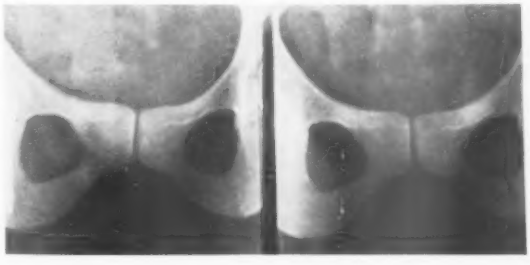

Fig. 5. The "special studies" in a normal female. Motion at the pubis in the female may be as much as 1.5 mm., though 1 mm. is more usual. More than 2 mm. has invariably been accompanied by symptoms, in our experience, and more than 1 mm. may be significant.

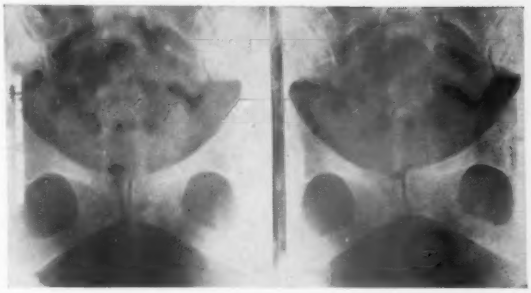

Fig. 6. The special studies in a case of marked sacroiliac joint relaxation. The patient's weight is on the side which bears the "marker" or label.

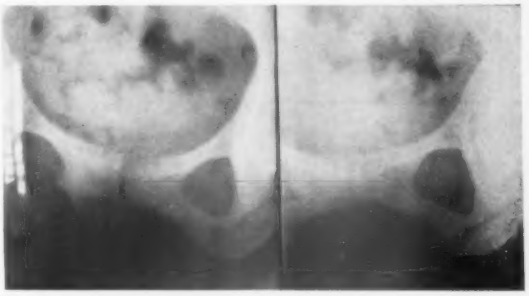

Fig. 7. This patient exhibited asymmetry and gaping at the symphysis even when lying supine (see Fig. 2), but the true condition, shown by the "special studies," is relaxation, not "slip."

With this technique, we first studied normal individuals, with results as indicated in Figures 4 and 5. Normal movements measured at the pubes amount to from 0 to 0.5 mm. in the male, and from 0 to 1.5 mm. in the non-pregnant female.*

* Very early in pregnancy the pelvic joints become relaxed, and there is reason to believe that some of the backaches of menstruation may be due to a temporary sacroiliac relaxation. Further studies are under way with reference to the possibility of roentgen demonstration of cyclic (menstrual) changes in the degree of motion of the female pelvic joints.

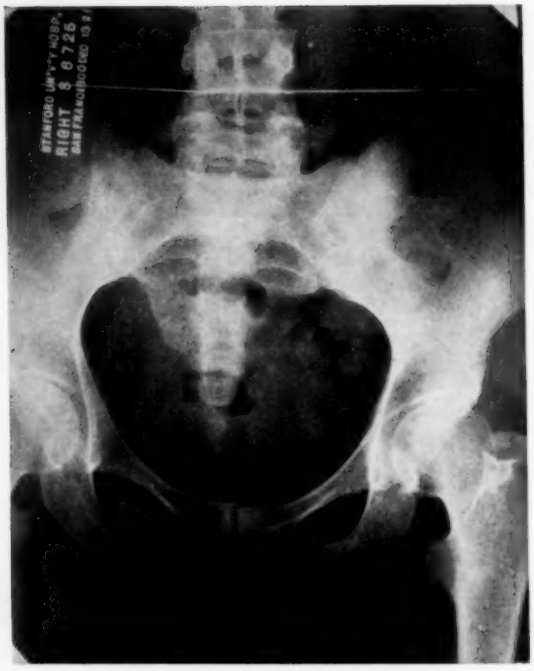

FIG. 8. Pelvis of Mrs. B. This film, part of a stereoscopic study, shows elevation of right pubis due to rotation of right innominate bone. At the time this study was made, patient presented the typical clinical picture of "right sacroiliac slip."

In the ten years since the above described technique was adopted, we have found our most fruitful field in the realm of sacroiliac "relaxation" (see Figs. 6 and 7), but occasionally we have been able to demonstrate what is apparently a fixed slip. Mrs. B. (Figs. 8 and 9) presented the painful picture of a right sacroiliac slip (in accordance with the clinical concepts of Goldthwait and Osgood). The roentgen examination disclosed a right innominate bone rotation (right pubis higher than left). After manipulation and bed rest, all symptoms subsided. Some months later this patient was brought back and examined again, and the innominate bones were found to be quite symmetrically disposed.

At this point, attention is called to four important points: (1) In studying the pelvis for an asymmetry of the type illustrated in Figures 8 and 9, the entire pelvic brim must be studied, stereoscopically. The pubes themselves are sometimes developmentally different from each other, and we have seen a hypertrophic arthritic change build up one pubic margin higher than the other. These local changes will not be confused with true innominate bone rotations if the observer will study, in the stereoscope, the symmetry or asymmetry of the brim of the pelvis as a whole.

(2) We cannot claim to have proved that the so-called "slip" is the primary factor in the acute low back episode called "sacroiliac slip." Our definite demonstration of innominate bone rotation in these cases could be equally well explained by assuming certain muscle spasms, pulling the rotated innominate bone from its usual position. No attempt is made, at the present time, to decide which is cause and which is effect.

(3) In our own experience, the patient's acute sacroiliac symptoms have almost invariably been on the side of the high pubis. In only about a tenth of the cases have they been on the side of the low pubis. In this

FIG. 9. Same case as Figure 8. This study was made at a time when the patient was free from sacroiliac symptoms. Note the comparatively symmetrical pelvis.

Fig. 10. Tuberculosis of the symphysis pubis. This patient did not complain of any abnormal sensations at the symphysis, but had all the symptoms of a "sacroiliac slip" on the side of the high pubis.

connection, attention is called to the anatomy of the ligaments of the sacroiliac joint. The strongest ligaments run in such a direction that the fibers are tightened when the pubis moves caudad and loosened when the innominate rotates in the opposite sense.

(4) The ligaments at the symphysis pubis may be of considerable importance to the stability of the sacroiliac joints. We have several cases which suggest that destructive joint disease at the symphysis produces its first and sometimes its only symptoms in the sacroiliac region (see Fig. 10).*†

SUMMARY

The ordinary roentgen examination of the sacroiliac region does not demonstrate the presence of sacroiliac relaxations or subluxations. For about ten years, we have successfully used the following technique for the demonstration of these conditions: Five films are exposed—a stereoscopic pair in posterior projection, patient supine on the Potter-Bucky diaphragm table, with film size and centering adjusted so as to include the symphysis pubis and the entire pelvic brim in the field; a lateral projection centered at the lumbrosacral junction; and two anterior projections of the symphysis pubis, patient standing, facing a vertical Potter-Bucky diaphragm, as illustrated in Figure 3, one film being made with the patient's weight borne on the right leg, the other with his weight on the left leg.

The above method of examination has served to successfully diagnose "sacroiliac slip" (innominate bone rotation with more or less fixation), and sacroiliac relaxation.

* The author wishes to express his sincere thanks to Drs. Leonard W. Ely and Arthur L. Fisher, of the Department of Orthopedic Surgery, for their valued help and clinical advice.

Dr. Ely recently called my attention to the work of Allen.[1] Apparently he has arrived, independently, at a very similar technique for the roentgen examination of the sacroiliac region.

† In 1928, Dr. Sante,[3] of St. Louis, who heard this paper read in September, 1922, wrote me that he had corroborated these concepts in a very large series of cases.

REFERENCES

1. Allen, H. R. The ilio-sacral joint. *Indianapolis M. J.*, 1923, *26*, 151–155.

2. Goldthwait, Joel E., and Osgood, Robert B. A consideration of the pelvic articulations from an anatomical, pathological and clinical standpoint. *Boston M. & S. J.*, 1905, *152*, 593–601.

3. Sante, L. R. Personal communication.

4. Snelling, Frederick G. Relaxation of the pelvic symphyses during pregnancy and parturition. *Am. J. Obst.*, 1870, *2*, 561–596.

THE EFFECT OF PHRENICECTOMY ON PULMONARY CAVITATION

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IN RECENT years pathologic anatomists and clinicians have pointed out the important rôle that cavities play in the prognosis of pulmonary tuberculosis. The classical roentgen pictures of pulmonary cavities with their draining bronchus leading to the hilus, and fluid levels are described in any standard atlas of roentgenology. Rarefied areas in the center of infiltrations, and faintly outlined annular shadows, with few exceptions are now classified as cavities. In cases where the classical physical signs of cavity are absent the roentgenogram should be the deciding factor. Various authors claim that from 5 to 80 per cent of all pulmonary cavities in tuberculosis are silent. These silent cavities are of at least two kinds: (*a*) absolutely mute, that is, those which exhibit no adventitious breath sounds at all, and (*b*) relatively silent, that is, those cavities which lack the classic cavernous signs but manifest other adventitious sounds such as bronchovesicular breathing and moist rales. The examination of the sputum for elastic fibers and tubercle bacilli is an aid in arriving at a diagnosis of cavitation. As the cavities diminish in size, the amount of sputum and number of tubercle bacilli decrease, but when the cavities reopen or grow larger, both increase. Tubercle bacilli in the sputum in the presence of an annular shadow in the roentgenogram, strengthens the diagnosis of the latter as cavitation. Pinner, from histological studies and serial roentgenograms, has described three types of cavities. Roentgenologically, these three types are, briefly, as follows: (1) small, multiple cavities in densely infiltrated parenchyma, the roentgen appearance of which is frequently described as "moth eaten areas;" (2) sharply defined, almost completely round or slightly oval cavities, either with heavy perifocal infiltration or with thin, clearly defined borders, and (3) irregularly shaped cavities with dense walls, often of grotesque shape with marked irregularities in the walls.

Based upon the above classification a study of 200 cases of pulmonary tuberculosis with cavities 3 cm. or larger in diameter, was made. One hundred cases received routine rest cure. In 75 of the other group only phrenicectomy was done, while it was performed as an accessory to artificial pneumothorax in 25. The object of this paper is to determine the influence of phrenicectomy on the pulmonary cavity.

In the group of 100 cases which received no surgical treatment there were 66 cases with oval cavities and 34 with fibrotic walled cavities. Spontaneous closure of the cavities was observed in 14 cases. Serial roentgenograms revealed gradual shrinkage of the cavities to a small cloudy spot. These changes were accompanied by a decrease in the sputum and physical signs. Cavities 4 to 6 cm. in diameter have closed within a few weeks or months, only to reopen within a short period. The sputum was positive for tubercle bacilli in all of these cases. It became negative in 12 cases where the cavities closed. The cavities reopened in 6 cases and the sputum again became positive. The average stay in the sanatorium for these patients was three years. Forty per cent of these patients died during their stay in the hospital.

Table 1 shows the fate of the cavities in the group of 100 patients who received routine rest cure.

Phrenic exeresis should be done in tuberculous lesions requiring some form of collapse therapy but which are not considered sufficiently advanced for the use of artificial pneumothorax. It should also be done before a lung having an extensive lesion is

Table I

	Larger		Decreased		Closed	
	No.	Per cent	No.	Per cent	No.	Per cent
Thin walled (66)	46	69.7	8	12.1	12	18.1
Thick walled (34)	15	44.0	17	50.0	2	5.8

allowed to reëxpand after being kept down with pneumothorax for a period of years. In old fan-like mixed lesions at the apex, with or without cavity, that can rarely be controlled by pneumothorax, it is especially beneficial. In the thin-walled, infraclavicular cavities (2–4 cm. in diameter) left after an exudative lesion has attempted to heal by excavation, phrenicectomy is indicated. Phrenic exeresis is used as an adjunct to pneumothorax when adhesions to the lateral wall or apex prevent proper collapse of cavities. It is also indicated as a preliminary measure to thoracoplasty. Patients who need thoracoplasty but are poor risks, often obtain sufficient improvement following the operation on the nerve to prolong life or ease symptoms such as persistent cough and fever.

In the 100 cases in which the phrenic nerve was removed marked changes were observed in the roentgenograms.

Table II shows the fate of the cavities in the 100 surgically (phrenicectomy) treated cases.

In the group of 36 cases where only phrenicectomy was done there were 24 cases with thin-walled cavities and 12 cases with early infiltrations and moth eaten areas. Of the former group the cavities closed in 16, contracted in 6 and grew larger in 2; while in the latter group all closed. The sputum was positive for tubercle bacilli before operation in 24 cases and negative in 12. It was negative in 32 cases and remained positive in only 4 cases following the operation.

In 9 cases in which pneumothorax had been attempted and failed on account of pleural adhesions, phrenicectomy was done. The cavities closed in 2 cases, contracted in 6 and remained unchanged in one. Tubercle bacilli were present in the sputum of 8 cases and not demonstrable in one before the operation. After the operation the sputum became negative in 4 cases, remaining positive in 4.

Diaphragmatic paralysis was induced in 23 cases that were under artificial pneumothorax compression, in order to release adhesions and bring about the closure of cavities. There was relaxation of the adhesions with closure of the cavities in 14 cases, the cavities contracted in 5 and remained unchanged in 4. Tubercle bacilli were demonstrated in the sputum of all these cases before operation. It became negative in 11 cases after the operation. The phrenic nerve was removed in 2 cases during the reëxpansion of the lung. In these 2 cases it was easier for the reëxpanding lung to fill the chest completely, preventing a compensatory emphysema.

On 30 patients the operation was done to be followed by thoracoplasty. In 4 cases the cavities closed, decreased in 17,

Table II

	Larger		Stationary		Decreased		Closed	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Thick walled (21)	4	19.0	8	38.0	9	42.8	0	
Thin walled (67)	3	4.4	1	1.5	26	38.8	37	55.2
Moth eaten (12)	0		0		0		12	100.0

Table III

Treatment	Cavities closed	Cavities decreased in size	Cavities increased in size	Cavities closed and reopened	Sputum became negative
	Per cent	Per cent	Per cent	Per cent	Per cent
Routine sanatorium care. Bed rest.	14	25	61	42.9	0
Routine sanatorium care with phrenicectomy.	49	35	7	0	45.8

remained unchanged in 4, and grew larger in 5. In all of these cases the sputum was positive for tubercle bacilli. It became negative in the 4 cases where the cavities closed.

Table III presents a summary of the fate of the cavities in the group of cases that were treated with bed rest and the group of cases that were surgically treated.

Since the occurrence of excavations in pulmonary tuberculosis points to an unfavorable prognosis, the figures presented of the results following phrenicectomy on cavitation have been very encouraging. It is not the object of this study to discuss the clinical course, prognosis and end-results of these cases. Only the immediate effect of phrenicectomy on pulmonary cavitation is reported.

CASE REPORTS

Case 1. (Figs. 1, 2 and 3.) B. R., white female, aged twenty-six, admitted to the sanatorium, November, 1923, with an advanced bilateral pulmonary tuberculosis with cavitation. The sputum was heavily positive for

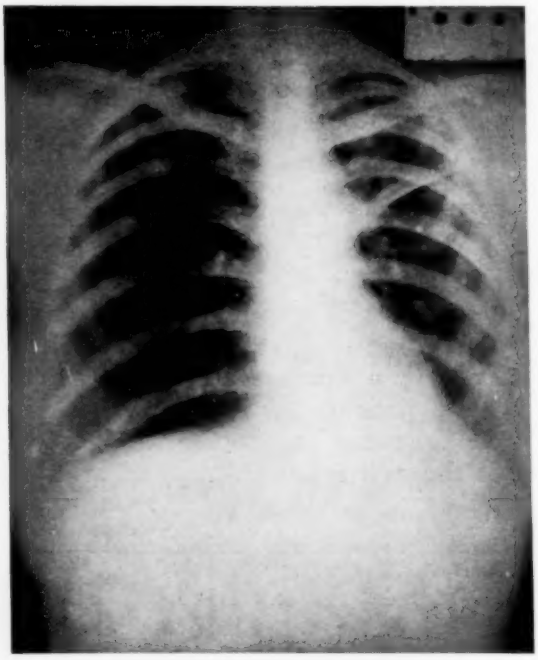

Fig. 1. Case 1. November, 1926. Shows an advanced tuberculous infiltration with cavitation in both apical regions.

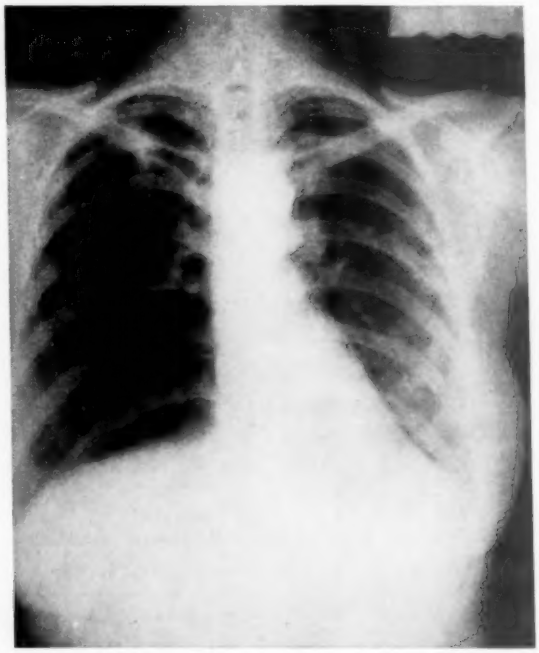

Fig. 2. Case 1. August, 1928. There has been resorption of the perifocal inflammation with closure of the cavities.

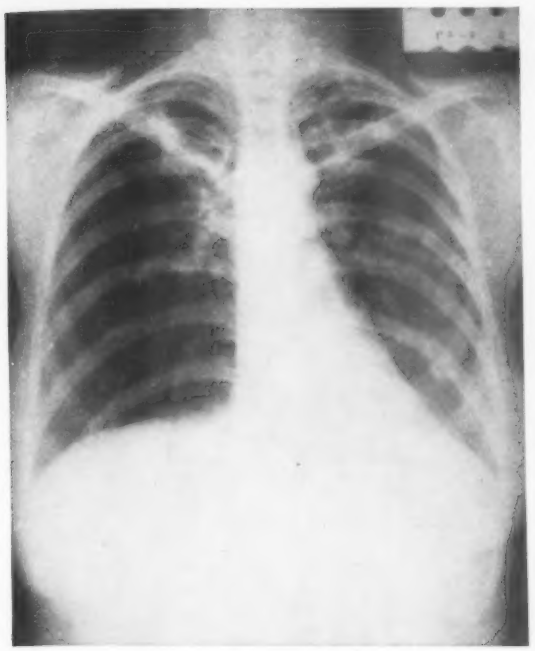

Fig. 3. Case I. August, 1929. The cavity in the left apical area has reopened.

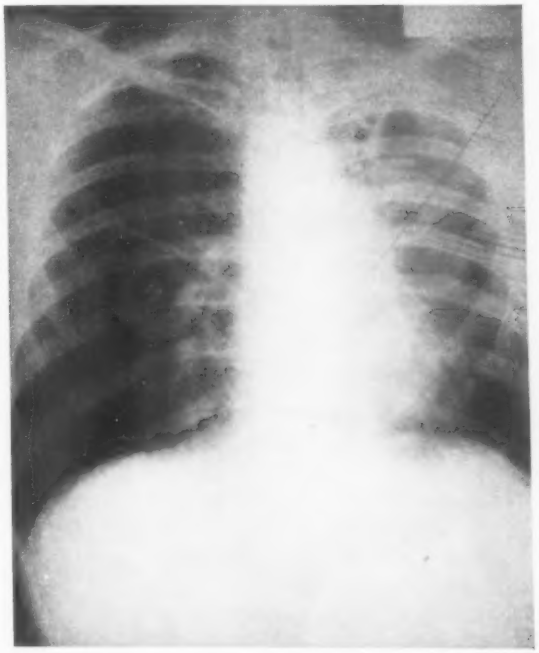

Fig. 4. Case II. Shows an advanced tuberculous process of the exudative type involving the upper half of the left lung. There is a cavity 4 cm. in diameter with much perifocal inflammation about it at the level of the second interspace. There is a small amount of fibrosis at the first and second interspace of the right lung.

Fig. 5. Case II. This roentgenogram was made five days after the removal of the phrenic nerve. The left leaf of the diaphragm is elevated 4 cm., and there is marked contraction of the cavity.

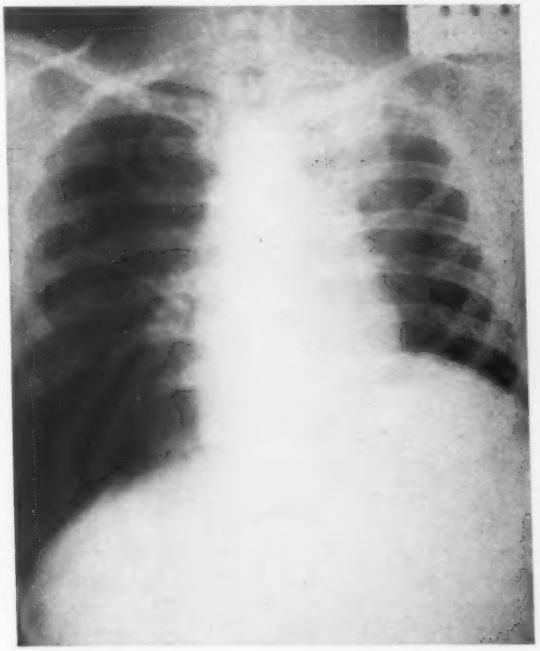

Fig. 6. Case II. The left hemidiaphragm is elevated 6 cm. and there is complete closure of the cavity.

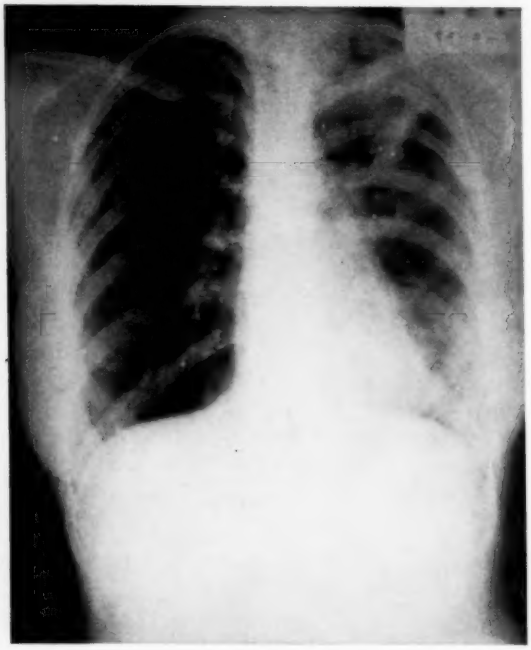

Fig. 7. Case III. Roentgenogram taken May 2, 1929. There is an advanced tuberculous process, productive in type, involving the upper two-thirds of the left lung. A cavity measuring 3 cm. in diameter is present at the level of the second interspace. The right lung is clear.

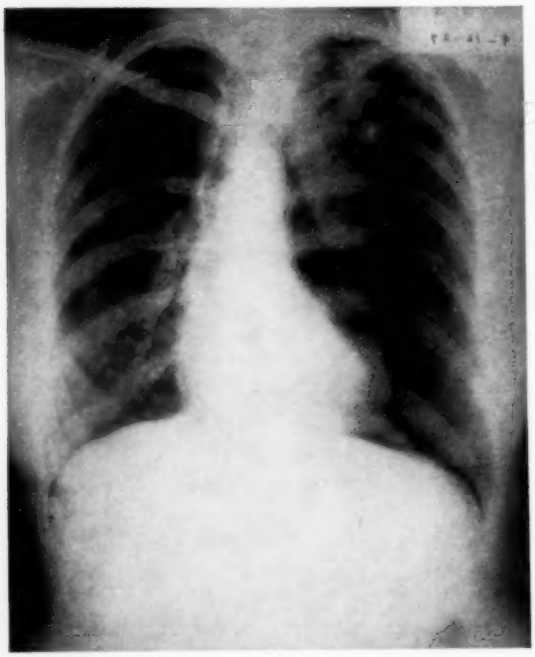

Fig. 8. Case III. Roentgenogram taken in September, 1929. An artificial pneumothorax has been induced. Dense bands of adhesions in the apical region prevent closure of the cavity.

tubercle bacilli. Routine sanatorium rest cure was carried out for five years. She left the sanatorium in August, 1928; the cavitation had closed and sputum was negative for tubercle bacilli. Roentgenograms made in August, 1929, revealed that the cavity in the left apex had reopened and the sputum was positive.

Case II. (Figs. 4, 5 and 6.) C. K., white male, aged thirty-three, admitted to the sanatorium in November, 1929, with an advanced pulmonary tuberculosis with cavitation of the left lung. The sputum was positive for tubercle

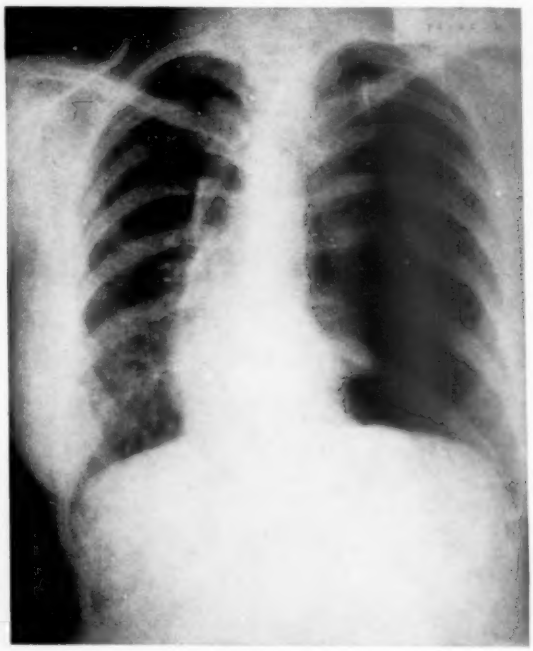

Fig. 9. Case III. Roentgenogram taken in November, 1929, after phrenicectomy. There has been relaxation of the adhesions with closure of the cavities. Sputum negative.

bacilli. An attempt was made to induce an artificial pneumothorax, but was unsuccessful. The phrenic nerve was removed on April 10, 1929, as a preliminary measure to thoracoplasty. One month after operation the cavity closed and the sputum became negative. All constitutional symptoms disappeared.

Case III. (Figs. 7, 8 and 9.) E. K., white female, aged twenty-two, admitted to the sanatorium in May, 1929, with an advanced pulmonary tuberculosis with cavitation of the left lung. Sputum positive for tubercle bacilli. An artificial pneumothorax was induced but apical adhesions prevented closure of the cavities. A phrenicectomy was done on Sept. 28, 1929, following which there was relaxation of the adhesions with closure of the cavity. Sputum became negative for tubercle bacilli.

Vol. XXIV, No. 6

THE ROENTGEN DIAGNOSIS OF CHRONIC APPENDICITIS*

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PRESENT day diagnosis of chronic appendicitis has attained a practical state of accuracy through the medium of the roentgen ray. In recent years, numerous articles have been written dealing with its merits and demerits, and it is the object of this paper to present our observations based on a series of 1000 consecutive gastrointestinal examinations.

Table II shows that out of 152 cases in which a diagnosis of chronic appendicitis was made, the appendix was visualized in 134. In 18 cases, we were unable to visualize the appendix at any time, but felt that a positive diagnosis of chronic appendicitis was justifiable.

Until 1911, little mention was made of the visualization of the appendix roentgenographically. This was probably due to the contrast meal in use at that time. With present day methods there is usually no difficulty in outlining the appendix. In our routine gastrointestinal work, we depend largely upon the roentgenoscope for determining the presence of any pathological condition in the appendix, using films chiefly to confirm the roentgenoscopic findings. We usually make several films of the stomach immediately following the first roentgenoscopic examination, and these are followed by six, eighteen and twenty-four hour films. When there is delayed emptying of the colon, forty-eight and seventy-two hour observations are made. This routine gastrointestinal examination is frequently followed by a barium enema.

TABLE I

THE INCIDENCE OF THE VARIOUS TYPES OF GASTROINTESTINAL PATHOLOGY ENUMERATED IN THE ORDER OF THEIR FREQUENCY

	Number	Percentage
Negative findings	220	22.0
Chronic appendicitis	152	15.2
Visceroptosis	112	11.2
Right upper quadrant pathology, including gall-bladder disease	108	10.8
Gastric carcinoma	78	7.8
Gastric ulcer	76	7.6
Colon stasis	69	6.9
Duodenal ulcer	56	5.6
Left and right lower quadrant adhesions	70	7.0
Pylorospasm	16	1.6
Colitis	10	1.0
Diverticulitis	8	0.8
Carcinoma of the cecum, ascending, descending and transverse colon	7	0.7
Carcinoma of the sigmoid	6	0.6
Cardiospasm	4	0.4
Esophageal carcinoma	2	0.2
Peritonitis with intestinal obstruction	2	0.2
Carcinoma of the pancreas	1	0.1
Carcinoma of the duodenum	1	0.1
Tuberculous enteritis	1	0.1
Gastric syphilis	1	0.1
	1000	100

* From the Roentgen Department of the University of Maryland.

Since roentgenoscopy plays such an important part in the examination, we deem it expedient to list a few of the most common observations. It is important to differentiate pain from discomfort caused by pressure. This can usually be determined by comparing the left with the right side. It is also essential to ascertain whether the pain is constant, intermittent, is practically empty, deep palpation will give rise to no discomfort.

It is not uncommon to have pain referred to the upper abdomen simulating that caused by a gastric or duodenal ulcer if pressure is continued over the appendix. This is probably explained by the complicated nervous mechanism in the splanchnic area.

TABLE II

THE DISTRIBUTION OF THE AGES, IN THE VARIOUS GROUPS AS WELL AS SEX, IS SHOWN

Age	Number	Appendix Visualized	Appendix not Visualized	Male	Female
1 to 10	6	4	2	2	4
10 to 15	2	1	1		2
15 to 20	3	2	1	2	1
20 to 30	38	34	4	15	13
30 to 40	52	45	7	39	23
40 to 50	30	27	3	18	12
50 and over	21	21	0	11	10
	152	134	18	87	65

TABLE III

PERCENTAGE OF AGREEMENT BETWEEN THE ROENTGEN AND CLINICAL FINDINGS IN THE 152 CASES

	Number	Percentage
Patients discharged with diagnosis of chronic appendicitis after a most careful clinical investigation	86	56.6
Patients operated upon and diagnosis of chronic appendicitis confirmed	47	30.9
Patients in whom the diagnosis was not confirmed either clinically, or by operation	19	12.5
	152	100

or varies from day to day. Occasionally, patients will complain of pain over the appendix upon pressure the first day, but the following day, deep palpation will cause no discomfort whatever. These observations have been described by Bierman who attributes them to varying degrees of intracolonic pressure. When the cecum is full, and deep palpation is made, there is immediately an increase in the intracolonic pressure within the already distended cecum. Increasing the distention in this manner gives rise to pain. When the cecum

In the series herewith presented, the diagnoses were based on the following findings:

A. Direct Evidence.

1. A visualized appendix tender to palpation.

2. Delayed emptying of the appendix (48 or 72 hour residue after the cecum is empty).

3. A bulbous tip with a small lumen near the cecum.

4. A persistent angulation or kink in the appendix.

5. Fixation of appendix by adhesions at the tip or throughout its entire length.

6. Filling of the appendix in parts or segments.

7. Presence of concretions.

B. Indirect Evidence.

1. Ileal and colonic stasis.

2. Spasticity or atony of the cecum.

3. Stasis in the cecum after the entire colon is empty.

4. Pylorospasm.

It is important to exclude, either by physical examination, or by roentgenograms, the following conditions that may simulate chronic appendicitis.

1. Ovarian disease.
2. Renal calculus.
3. Sacroiliac strain.
4. Psoas abscess.
5. Peptic ulcer.
6. Gall-bladder pathology.
7. Lobar pneumonia, right base.

In a number of cases, we were able not only to demonstrate an appendix which could account for the symptoms, but right upper quadrant pathology as well. That a definite relation exists between chronic appendicitis and upper abdominal pathology cannot be denied. Deaver and Ravdin examined the appendices removed from 76 cases of gall-bladder disease and 18 cases of gastric and duodenal ulcer. They found that the appendix was definitely diseased in 90 per cent of the gall-bladder cases and in 61 per cent of the ulcer cases.

The routine gastrointestinal examination will occasionally fail to reveal positive evidence of a pathological appendix, even with a study of the colon after a barium enema. It is only after a most careful clinical study, including the history and physical examination in conjunction with the roentgen findings, that a positive diagnosis can be made.

CONCLUSIONS

1. In a routine study of 1000 consecutive gastrointestinal examinations, there was roentgen evidence of a pathological appendix in 152 instances, or 15.2 per cent.

2. This diagnosis was confirmed either clinically or at operation in 133 cases, or 87.5 per cent.

3. The incidence of appendicitis was noted to be greatest between the ages of twenty and fifty years.

4. Of the direct evidences, the visualized appendix which empties slowly and is persistently tender to palpation is the most common.

5. Of the indirect evidences, the ileal and colonic stasis are the most common.

6. An even greater percentage of correct diagnoses will be obtained if the clinical studies are closely correlated with the roentgen findings.

REFERENCES

1. Bierman, M. I. Chronic appendicitis; bases for varied clinical manifestations. *Radiology*, 1925, *5*, 152–157.
2. Case, J. T. Further x-ray studies on the ileocecal valve and the appendix. Am. J. Roentgenol., 1914, *1*, 376–388.
3. Deaver, J. B., and Ravdin, I. S. End-results of 500 cases of chronic appendicitis. *Arch. Surg.*, 1923, *6*, 31–40.
4. Dowden, J. W. Diagnostic difficulties in chronic appendicits. *Brit. M. J.*, 1927, *2*, 1066.
5. Hurst, A. F. *Arch. Roentg. Ray.*, 1914, *19*, 249.
6. Imboden, H. M. Roentgen diagnosis of lesions of vermiform appendix. Am. J. Roentgenol., 1915, *2*, 581–591.
7. Quimby, A. J. Differential diagnosis of the appendix by aid of the Roentgen ray. *N. York M. J.*, 1913, *98*, 697–705.

ROENTGEN-PHYSIOLOGICAL STUDIES ON THE GALL-BLADDER*

EXPERIMENTS WITH LIPIODOL AND BROMINOL-LIGHT ON THE DOG

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THE content of the biliary vesicle may be rendered opaque to roentgen rays by a direct or an indirect method. The direct method consists of withdrawing and replacing the content of the gall-bladder by a radiopaque substance. The indirect method is that invented and perfected by Graham and his coworkers (1924).[7,8] This consists of intravenous or oral administration of a radiopaque substance which appears in the bile and reaches the lumen of the gall-bladder per vias naturales. Inasmuch as the bile is resorbed faster than the radiopaque substance, the latter eventually becomes concentrated enough to cast a shadow roentgenologically.

The present studies are concerned with the direct method of visualization of the biliary vesicle, and were undertaken with the aim of evaluating the available data obtained by this method and of gaining further information regarding the mechanism of the function of the gall-bladder.

HISTORICAL REMARKS

Burckhardt and Müller (1921)[5] were the first to apply the direct method of visualization of the gall-bladder in dogs and human beings. In their preliminary studies on the cadaver they used collargol or air or both as contrast medium, and later either collargol or pyelon. They opened the abdomen and filled the gall-bladder with collargol in three dogs and with pyelon in one. In two of the dogs whose gall-bladder was filled with collargol a shadow of the gall-bladder content was obtainable up to seventy-two and thirty-six hours respectively; the shadow persisted longer in the third dog in which previous to the injection the cystic duct was ligated. The shadow produced by pyelon disappeared at about the forty-eighth hour following the injection. In one patient collargol and in another pyelon was injected into the gall-bladder under local anesthesia, and the roentgenographic findings were verified by a subsequent operation. In four more patients the procedure (with collargol) was applied under general anesthesia. In two of these the procedure was unsuccessful, because of atrophy of the vesicle in one, and tumor in the other. In all of these patients laparotomy and radical operation followed the attempt of cholecystography.

Abramson (1924)[1] injected sodium iodide or neosilvol (Parke-Davis), a silver-protein-iodide compound, into the gall-bladder of six dogs and studied the roentgen shadows thus produced while the animals were recovering from anesthesia, after anesthesia, and a number of days following the operation. Abramson made the following observations: (1) Spontaneous expulsion of about 3 c.c. of the content of the gall-bladder occurred in a dog which had been cholecystostomized five days previous to the observation and whose gall-bladder was visualized by the injection (through a tube) of 4 c.c. of a 150 per cent solution of sodium iodide. (2) By manual pressure on the abdominal wall the content of the gall-bladder could be forced to leave the viscus. (3) Movements of the animal did not result in expulsion of material from the gall-bladder.

Potter and Mann (1926)[13] filled the gall-bladder of a dog through a cholecystostomy tube with "barium solution" and

* This work has been conducted under the joint auspices of the Douglas Smith Foundation for Medical Research and the Otho S. A. Sprague Memorial Institute.

observed spurts of opaque material projecting from the neck of the viscus at intervals.

Whitaker (1926)[16] on introducing iodized oil into the gall-bladder of a dog observed the shadow of the opaque oil in the biliary ducts at intervals after ingestion of a meal rich in fat, and noted at the same time a marked decrease in size of the shadow thrown by the gall-bladder content.

Whitaker and Boyden (1926)[17] injected iodized oil "into the fundus of the gall-bladder" and then fed "these animals" (cats?) with egg-yolk as soon as they had completely recovered from the operation. They thus made use of Boyden's observation[3] that a meal of egg-yolk and cream would cause the distended gall-bladder of a cat nearly to collapse within an hour and three-quarters, and of Whitaker's method of visualizing the biliary vesicle. On roentgenograms taken at frequent intervals Whitaker and Boyden observed that the iodized oil entered the cystic duct, outlined the common bile duct and appeared in the small intestine in five, ten and fifteen minutes respectively, after feeding. In a systematic study Whitaker[18] amplified these observations. In cats which had fasted for at least twenty-four hours, he replaced the content of the gall-bladder with iodized oil aseptically. The animals were then kept deprived of food for from sixteen to thirty hours and then fed egg-yolk. Roentgenologic observations proved that under these conditions, iodized oil appeared in the biliary ducts and the duodenum, while the shadow thrown by the content of the gall-bladder had decreased in size. Boyden,[4] working with the iodized oil method, observed that in cats a meal of egg-yolk, shaving of the leg of the animal, or incision of the skin, or transfusion of blood from fasting animals, caused a definite extrusion of oil from the gall-bladder; intravenous injection of barium chloride, pituitrin or cholin hydrochloride caused expulsion of iodized oil into the common duct. He also found that intravenous injection of adrenalin chloride (Parke-Davis) "causes a greater expulsion of iodized oil from the gall-bladder than any reagent hitherto employed."

Hamrick (1927)[10] experimented on dogs. He fasted them for twenty-four hours previous to operation, which consisted of withdrawing, by means of a syringe, a certain amount of bile from the gall-bladder and replacing it with the same amount of lipiodol, using ether anesthesia and aseptic technique. The animals were fasted after the operation until observations were to be made. With one exception there was no evidence of emptying of the gall-bladder during fasting, as a result of ordinary movements, or repeated firm external pressure over the area of the gall-bladder. Roentgenograms taken following vomiting or the act of defecation did not show emptying. Passage of a stomach tube, its manipulation and other maneuvers, as filling the stomach with air, and aspiration of the content, resulted in expulsion of material from the gall-bladder in a number of animals. A feeding of 300 to 500 c.c. of egg-yolk and cream mixture was usually followed within from ten to forty-five minutes by the passage of opaque substance from the gall-bladder through the cystic and common bile ducts into the duodenum.

Ivy and Oldberg (1928)[11] filled the gall-bladders of ten dogs with from 15 to 20 c.c. of lipiodol (after the same amount of bile had been withdrawn) under morphine-ether anesthesia and with aseptic technique. The animals received no food. From eighteen to twenty-four hours after the operation, a purified preparation of secretin (which they called cholecystokinin) was injected intravenously every ten minutes for one hour, and the effects studied on roentgenograms taken from two to ten minutes apart. These roentgenograms and subsequent necropsy findings showed that all but about 3 c.c. of lipiodol had been evacuated in three of the ten animals, about two-thirds in three, one-half in three and a small amount in one.

Krause and Whitaker (1928)[12] used iodized oil to visualize the gall-bladder in

their study of the effects of ingestion of various food substances upon the gall-bladder of the cat.

Valdoni (1930)[15] introduced lipiodol into the gall-bladder of a cholecystostomized patient and noted the presence of radiopaque material in the biliary ducts and in the small intestine an hour later after the patient had taken a glass of milk.

Birch and Boyden (1930)[2] employed the iodized oil method in their recent study of the reactions of the cat's gall-bladder to faradic stimulation of the stomach, small intestine and cecum.

Crandall (1930)[6] filled the gall-bladders of five dogs with brominol-light and observed a partial spontaneous emptying of the viscus within five hours, even though the animals were given nothing by mouth.

As shown by the above brief review, Burckhardt and Müller were the pioneer workers in the field of cholecystography. Although they failed to develop the direct method for clinical use, they were the first to produce cholecystograms. The ambition of all the other investigators who applied the direct method, has been to visualize the gall-bladder in action. This review also enumerates the substances used for cholecystography and shows that lipiodol holds a popular place among them. Its high iodine content (about 40 per cent) makes lipiodol particularly useful in visualizing roentgenologically the course of ducts, burrowing sinuses, the position of cavities, etc. It is also an excellent medium for visualizing roentgenologically the dependent portion of the biliary vesicle. For the study of the finer mechanism of the gall-bladder, however, it is most unsuitable because it does not mix with bile and both the specific gravity and viscosity are far greater than that of the ordinary content of the gall-bladder. Furthermore the shadow which it produces is too dense to permit the observation of any detail. Two more criticisms may justly be made of most of the above experiments. In the first place, it is practically certain that replacement of most of the content of the gall-bladder with a heavy oil-like lipiodol must interfere with its normal function. The other is that fasting before and after operation necessarily upsets all activities of the gastrointestinal tract, and therefore the responses obtained under such circumstances can hardly be a measure for ordinary functions in the everyday life of an animal.

In our experiments the amount of lipiodol introduced into the gall-bladder was limited to 2 c.c. and the animals were returned after the operation to their usual environment and diet as soon as was practicable.

METHOD

Twenty-six normal healthy dogs were laparotomized: 2 c.c. of lipiodol was introduced into the gall-bladders of twenty, and brominol-light into six of the dogs after 3 c.c. of bile had been withdrawn. Following the operation the animals were replaced in their usual environment, were offered their usual diet, and an accurate record kept of their feeding. Roentgenograms were taken six hours after operation and subsequently once daily until the shadow had vanished or remained stationary for several days. In the latter case, a meal, consisting of raw chopped meat and two eggs, was fed, and a roentgenogram taken three hours later and one the following day.

EXPERIMENTS WITH LIPIODOL*

According to the data charted in Table 1, the shadow on the first films, i.e., six hours after the operation, averaged about 3.5 by 1.5 cm. (more accurately 3.36 by 1.75 cm.). The shadow disappeared completely in three dogs by the end of the second day, in five dogs on the third and fourth days, in six between the fifth and tenth days and in one on the seventeenth day. In the remaining five dogs the shadow diminished to about 30 per cent of its original size, and remained nearly unaltered until the experiment was concluded.

* A brief summary of the results of these experiments was read (by title) at the Forty-sixth Session of the American Association of Anatomists.[9]

TABLE I

EXPERIMENTS WITH LIPIODOL

Dog	Size of shadow of gall-bladder content (in mm.)			Feeding record
	Six hours after operation	Duration of experiment in days	At end of the experiment	
L-9 ♀ (9.5 kg.)	22 x 11	1	0 x 0	Ate regularly
L-1 ♂ (11 kg.)	48 x 20	2	0 x 0	Ate regularly
L-11 ♂ (5 kg.)	25 x 16	2	0 x 0	Ate regularly
L-3 ♂ (12 kg.)	30 x 15	3	0 x 0	Ate regularly
L-18 ♂ (11 kg.)	26 x 15	3	0 x 0	Ate regularly
L-7 ♂ (10 kg.)	25 x 18	3	0 x 0	Ate regularly
L-2 ♀ (7 kg.)	48 x 16	4	0 x 0	Ate regularly
L-10 ♂ (8 kg.)	17 x 15	4	0 x 0	Ate regularly
L-15 ♂ (16 kg.)	45 x 16	5	0 x 0	Ate regularly
L-13 ♂ (11 kg.)	34 x 18	6	0 x 0	Ate irregularly
L-5 ♂ (12 kg.)	18 x 13	6	0 x 0	Ate irregularly
L-17 ♂ (15 kg.)	68 x 14	7	0 x 0	Ate irregularly
L-6 ♂ (22 kg.)	32 x 18	8	0 x 0	Ate irregularly
L-8 ♂ (5.6 kg.)	28 x 17	8	10 x 6	Ate regularly
L-20 ♂ (16 kg.)	26 x 20	10	0 x 0	Ate regularly
L-12 ♀ (10 kg.)	33 x 20	16	8 x 6	Ate regularly
L-19 ♂ (10 kg.)	30 x 17	17	0 x 0	Ate irregularly
L-4 ♂ (15 kg.)	37 x 20	22	21 x 7	Ate regularly
L-16 ♂ (15 kg.)	35 x 25	24	19 x 18	Ate regularly
L-14 ♂ (13 kg.)	45 x 26	26	18 x 12	Ate regularly

This occurred on the eighth day after operation in the case of one dog and from sixteen to twenty-six days in four other dogs.

At necropsy oil was recovered in the content of the gall-bladders of all of the five dogs in which the roentgen shadow persisted, but droplets of oil were found also in the gall-bladders of some of those dogs in which the shadow had disappeared.

EXPERIMENTS WITH BROMINOL-LIGHT

According to the data charted in Table II, the shadow on the first films, i.e., six hours after the operation, averaged about 2.8 by 2.1 cm. (more accurately 2.73 by 2.15 cm.). The shadow disappeared completely in two dogs by the end of the second, in two by the end of the fourth, and in one on the sixth day after the operation. One dog which refused food retained the shadow almost unaltered for seven days, at the end of which time she died.

At necropsy droplets of oil were found in the content of the gall-bladder in most of these dogs.

COMMENT

Both lipiodol and brominol-light sink to the bottom when mixed in vitro with bile. No tendency to go into solution was observed in mixtures that were allowed to stand for fourteen days at room temperature. The viscosity of lipiodol is 90 compared with water, while that of bile from the gall-bladder averages about 2, and that of brominol-light 5 (Crandall).[6] Due to their physical properties both lipiodol and brominol-light when introduced into the gall-bladder seek a position most dependent in the viscus. In fact it was noted in these experiments that if the gall-bladder was

tilted during the injection, in such manner that the orifice of the cystic duct was the lowermost point, the injected oil immediately ran out of the duct. Because of the difference in their viscosity, one would expect the elimination of lipiodol to be a greater task for the gall-bladder than the evacuation of brominol-light. In fact, for the disappearance of the shadow of lipiodol three to eight days were necessary in ten of the twenty dogs, and ten to seventeen days in two. In 25 per cent of the dogs the shadow diminished to about 30 per cent of its original size and remained nearly unaltered from eight to twenty-six days, in spite of several feedings with chopped meat and eggs. Brominol-light, on the other hand, was eliminated by the fourth day in four of the six dogs.

From experiments with methylene blue it was learned that a more or less complete exchange of the content of the gall-bladder usually occurs in the dog within about twenty-four hours.[14] From the above experiments it seems probable that a complete evacuation of the biliary vesicle never takes place in the dog. It is reasonable to assume that the exit of lipiodol and brominol-light occurs spontaneously when the orifice of the cystic duct happens to be the lowermost point. In those dogs in which, for some reason or other, this does not happen, the lipiodol remains in the gall-bladder almost indefinitely.

SUMMARY AND CONCLUSIONS

Twenty-six normal healthy dogs were laparotomized: 2 c.c. of lipiodol was introduced into the gall-bladders of twenty, and brominol-light into six of the dogs, after 3 c.c. of bile had been withdrawn. Following the operation the animals were replaced in their usual environment, and were offered their usual diet. Roentgenograms were taken six hours after the operation and subsequently once daily until the shadow had vanished or remained stationary for several days. In the latter case, a meal, consisting of raw chopped meat and two eggs, was fed, and a roentgenogram taken three hours later and one the following day.

In the experiments with lipiodol, the shadows on the first films averaged about 3.5 by 1.5 cm. The shadow disappeared completely in three dogs by the end of the second day, in five dogs on the third and fourth days, in six between the fifth and tenth days, and in one on the seventeenth day. In the remaining five dogs the shadow diminished to about 30 per cent of its original size and remained nearly unaltered until the experiment was concluded, i.e., eight to twenty-six days after operation.

In the experiments with brominol-light, the shadows on the first films averaged about 2.8 by 2.1 cm. The shadow disappeared completely by the fourth day in four of the six dogs.

TABLE II

EXPERIMENTS WITH BROMINOL-LIGHT

Dog	Size of shadow of gall-bladder content (in mm.)			Feeding record
	Six hours after operation	Duration of experiment in days	At end of the experiment	
B-2 ♀ (12 kg.)	28 x 21	2	0 x 0	Ate regularly
B-4 ♀ (11 kg.)	28 x 20	2	0 x 0	Ate regularly
B-3 ♀ (10 kg.)	31 x 30	4	0 x 0	Ate regularly
B-6 ♂ (8 kg.)	26 x 23	4	0 x 0	Ate regularly
B-1 ♂ (15 kg.)	28 x 15	6	0 x 0	Ate regularly
B-5 ♀ (10 kg.)	23 x 20	7	22 x 20	Refused food.

At necropsy, droplets of lipiodol or brominol-light were found in the content of the gall-bladder in most of those dogs in which the shadow had disapperaed.

The exit of lipiodol and brominol-light occurred spontaneously whenever the orifice of the cystic duct became the lowermost point of the viscus. In dogs in which, for some reason or other, this did not happen, the lipiodol remained in the gall-bladder almost indefinitely.

The above observations justify the conclusion that complete emptying of the dog's gall-bladder does not occur with each meal; furthermore it seems probable that a complete evacuation of the biliary vesicle never takes place in the dog.

REFERENCES

1. Abramson, Harold A. Visualization of the gall bladder of the dog by the Roentgen ray. *Proc. Soc. Exper. Biol. & Med.*, 1923–1924, *21*, 407–409.
2. Birch, Carroll L., and Boyden, Edward A. Reaction of gall bladder to stimulation of gastrointestinal tract. *Am. J. Physiol.*, 1930, *92*, 301–316.
3. Boyden, Edward A. The effect of natural foods on the distention of the gall bladder, with a note on the change in pattern of the mucosa as it passes from distention to collapse. *Anat. Rec.*, 1925, *30*, 333–363.
4. Boyden, Edward A. A study of the behavior of the human gall bladder in response to the ingestion of food; together with some observations on the mechanism of the expulsion of bile in experimental animals. *Anat. Rec.*, 1926, *33*, 201–255.
5. Burckhardt, H., and Müller, Walther. Versuche über die Punktion der Gallenblase und ihre Röntgendarstellung. *Deutsche Ztschr. f. Chir.*, 1921, *162*, 167–197.
6. Crandall, Lathan A. A study of possible mechanisms for gall bladder contraction and evacuation. *Am. J. Physiol.*, 1930, *93*, 642.
7. Graham, E. A., and Cole, W. H. Roentgenologic examination of the gall-bladder, new method of utilizing intravenous injection of tetrabromphenolphthalein. *J. Am. M. Ass.*, 1924, *82*, 613–614
8. Graham, E. A., Cole, W. H., Copher, G. H., and Moore, Sherwood. Diseases of the Gall Bladder and Bile Ducts. Lea and Febiger, Philadelphia, 1928.
9. Halpert, Béla, and Rewbridge, Allan G. Roentgenological studies on the gall bladder of the dog. Experiments with lipiodol. *Anat. Rec.*, 1930, *45*, 262.
10. Hamrick, Robert A. The emptying of the gall bladder; an experimental study. *Am. J. M. Sc.*, 1927, *174*, 168–181.
11. Ivy, A. C., and Oldberg, Eric. A hormone mechanism for gall-bladder contraction and evacuation. *Am. J. Physiol.*, 1928, *86*, 599–613.
12. Krause, William F., and Whitaker, Lester R. Effects of different food substances upon emptying of the gall-bladder. *Am. J. Physiol.*, 1928, *87*, 172–179.
13. Potter, J. C., and Mann, F. C. Pressure changes in the biliary tract. *Am. J. M. Sc.*, 1926, *171*, 202–217.
14. Rewbridge, Allan G., Hanke, Milton T., and Halpert, Béla. Further observations on the function of the gall bladder. Experiments with methylene blue on the dog. *Am. J. Physiol.*, 1930, *95*, 511–518.
15. Valdoni, Pietro. Studi sul potere di assorbimento della cistifellea normale e patologicamente alterata. *Policlinico* (*sez. chir*), 1930, *37*, 8–32.
16. Whitaker, L. R. Experiences with cholecystography, including observations on the function of the gallbladder. *J. Am. M. Ass.*, 1926, *86*, 239–243.
17. Whitaker, L. R., and Boyden, E. A. Observations on the function of the gall bladder. *Am. J. Physiol.*, 1926, *76*, 199.
18. Whitaker, L. R. The mechanism of the gall bladder. *Am. J. Physiol.*, 1926, *78*, 411–436.

EXPERIMENTAL STUDIES ON TISSUE REACTION TO RADIATION USING A SEGMENT OF A GROWING MOUSE TAIL AS A BIOLOGICAL INDICATOR

I. METHODS AND GENERAL REACTIONS*

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THE effects of radiation have been measured by various indicators. The chemical changes produced in a photographic plate as a result of exposure to roentgen or radium radiation are well known. Changes occur when certain chemical solutions are exposed to various types of radiation. Seedlings, protozoa, eggs of *Ascaris* and *Drosophila*, tadpoles, etc., have been used as biological indicators. The well-known skin erythema reaction is used extensively as a clinical measure of roentgen rays and plays a similar rôle in experimental biophysical investigations.

The above reactions to irradiations cannot supplant the physical measurements which are based on ionization of air; still each method of determination has its own advantage. Certain unicellular forms and invertebrate ova can be obtained in almost unlimited quantities, yet there are facts concerning the biological response to radiation which these forms are not well adapted to bring out. It seems to us that the human skin erythema reaction more nearly meets the requirements as a practical clinical measure of irradiation, and yet here again the investigator is limited in the number of subjects, and to a certain degree the individual differences that occur in response to similar treatments make for an unavoidable error in calculation.

We have attempted to study the usefulness of a different form of tissue reaction to measure radiation effects. Our aim was to obtain an indicator relatively small in size, uniform in structure, mammalian, active in growth and easily obtainable in experimental laboratories throughout the year. It is desirable to employ a small volume of test tissue in order that the intensity of radiation be as uniform throughout the mass as possible. In the case of the skin erythema reaction the biological changes that are recorded occur in the tissues mainly in a plane immediately below the treated surface.

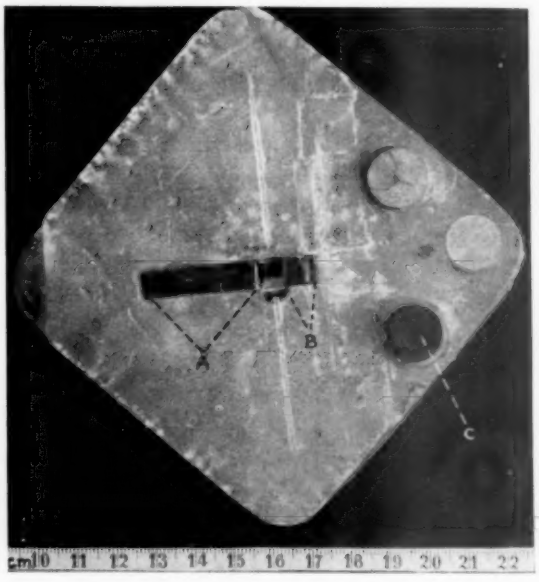

FIG. 1. Top view of the large paraffin block used to hold the lead applicators in place. A. Lead bar into which the distal portion of the tail is placed. B. Shorter lead bar protecting proximal portion of tail. The area between these bars is occupied by a small paraffin block directly above the tail segment which is to be irradiated. C. Top view of one of the three rubber pillars used to support the shield on which the mouse is held.

* Read at the Fifteenth Annual Meeting, American Radium Society, Detroit, Mich., June 23–24, 1930. The investigation has been aided in part by a grant from the Committee on the Effects of Radiations upon Living Organisms of the National Research Council.

It is the purpose of this paper to describe a new method which satisfies the above criteria fairly well, to indicate the stages employed in its use, to give an account of the tissue reactions that occur, and to consider the usefulness of the method in different experimental procedures.*

EXPERIMENTAL METHODS

We used as our measure of biological response to irradiation, the tissue reactions that occur in a central segment of the tail of a young mouse (see "E", Fig. 3). Animals seven, eight or nine days old were selected, as within this group the tissues employed are essentially similar. Most of the animals were obtained from an inbred, homogeneous stock of albino mice that the senior author has had under observation for the last seventeen years. Lately we have found that a pigmented tail may also be used to advantage in this work, and here we have selected a strain of so-called brown mice that have been studied for nine years through twenty-two generations of pedigree breeding.

Fig. 2. Top view of paraffin block showing the lead shield in place, D, and the portion of the tail to be irradiated at E.

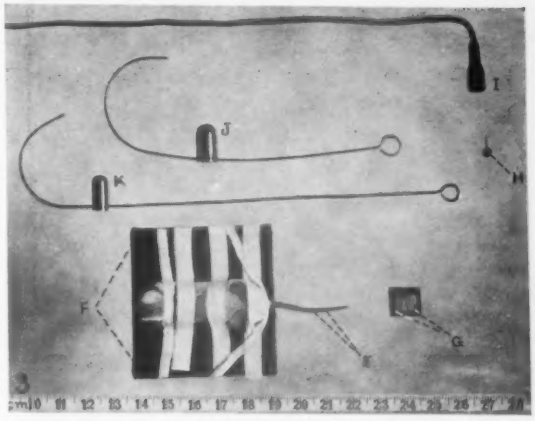

Fig. 3. The young mouse is shown fastened to lead shield, F. The segment of the tail that was irradiated is shown at E. The small grooved paraffin block that fits over E of Figure 2, is shown at G. H. Small glass bulb which is placed in holder, I, and is used when a strong beta-ray radon exposure is given. The same bulb is placed in a brass applicator, J, which is shown in a side view, and affords a filtration of 2 mm. of brass. K. A similar brass applicator which affords 1 mm. brass filtration. The wire rods run through the top of the two applicators respectively. They aid in handling the applicators and prevent the glass bulb from leaving the hollow center of J and K respectively.

The average length of the tail of an eight day mouse is 30 mm. in the albino stock and approximately 28 mm. in the colored mice. At this age the diameter of the tail, approximately 10 mm. from the tip, is 1.5 mm. The radiation was applied at that portion of the tail where the diameter was 1.5 mm. A segment 5 to 7 mm. long was treated, or approximately a volume of 9 to 12 cubic millimeters. In order to shield the body of the animal and the distal and proximal regions of the tail, these regions were protected by lead. The tail was "threaded" through holes that were drilled in rectangular bars of lead (see "A" and "B", Fig. 1). These bars were 5×5 mm. at the ends and 20 and 8 mm. long respectively. The shorter piece fitted over the proximal portion of the tail and the distal region was covered

* At this time the writers wish to express their thanks to Dr. Hayes E. Martin for his suggestions and active cooperation and interest throughout the course of the experiments, and to Dr. G. Failla and Mrs. Edith Quimby for their aid in the physical considerations involved in the work.

by the longer one. The extent of the segment of the tail to be irradiated was determined by moving apart the lead bars to the desired distance. The hole in the lead through which the tail fitted was drilled acentrically so that the dorsal portion of the tail was protected by 3 mm. of this metal. The lead bars were held in place by sinking them in a block of paraffin 105 ×105 × 95 mm., as shown in Figure 1. A portion of one corner of the block was cut away to allow for the placement of the body.

The steps in the procedure incident to irradiating the tail are as follows. The mouse was placed on its back on a lead shield 55×55 mm. and 7 mm. thick, and was held in place by sling-like fastenings of adhesive strips which passed around its body and held it firmly to the lead block with its tail protruding from one edge (see "F", Fig. 3). The mouse was adjusted so that the movement of the tail in an anteroposterior direction was reduced to a negligible quantity, and still the animal was not restricted in its breathing and remained in place without discomfort. The tail was then "threaded" into the two lead bars described above, and the shield holding the mouse was placed on the three rubber pillars (sections of rubber stoppers cut to the proper height). Proper alignment of the lead shield on which the mouse was fixed and the lead bars into which the tail fitted was effected by a notch in the smaller lead bar which fitted into a similar notch in the lead shield cut just below that portion which shielded the proximal region of the tail. At this step in the procedure an extra block of lead was placed above the shield to still further protect the animal. The block had the same surface dimensions as the one on which the body was held, but was 13 mm. thick. The body was thus protected by 20 mm. of lead. The stage which the procedure has now reached is illustrated in Figure 2.

The next step was to cover the exposed segment of the tail, which was so placed that its dorsal surface was uppermost, with a small block of paraffin which fitted snugly into the space between the two lead bars. It was grooved and the upper one-half of the tail fitted into it. The thickness of the paraffin, from that portion which rested on the dorsal surface of the tail to the bottom of a radium applicator, varied with different applicators and its thickness determined the desired distance factor in the experimental set-up. This block had to be measured and replaced from time to time, as prolonged, intense irradiation tended to make it brittle and easily broken. The source of radiation was placed directly above the small paraffin block. When roentgen rays were used, the thickness of paraffin above the dorsal surface of the portion of the tail irradiated was 2.5 mm.

The irradiated tail segment was thus surrounded above, below (a groove was cut in the paraffin at its ventral surface similar to the one at the dorsal surface) and to the sides by paraffin, which it was expected would give a "scattering" effect in addition to the primary radiation which reached the tail. This scattering effect might be expected to simulate the scattering produced in tissues when treated by radiation. No attempt was made to prevent secondary radiation, from the ends of the lead bars, etc., from reaching the irradiated segment of the tail. However, this factor remained constant.

After the tail was irradiated, the small paraffin block was removed and a small mark of red ink was placed on that portion of the tail which was directly below the center of the source of radiation. The animal was then removed and the length of the tail recorded, from tip to anal margin.

The diameter of the tail at the red mark was also recorded, as well as the distance of the red mark to the tip of the tail. The mouse was given a catalog number which corresponded to identification marks cut in one or both ears, and it was returned to its nest cage.

GROSS ANATOMICAL CONSIDERATIONS

The tail of a young mouse is covered with soft, short hairs evenly distributed over

its entire surface. There is a regular annular arrangement of fine imbricating scales covering the entire tail. There are dorsal, lateral and ventral blood vessels, compact longitudinal bands of muscle and tendon fibers surrounding the tail vertebrae, which incloses the nerve cord. The ventral surface of the tail is slightly flattened.

DESCRIPTION OF TYPICAL, GROSS PATHOLOGICAL CHANGES THAT FOLLOW EXPOSURE TO RADIATION

Let us consider what takes place when a tail segment, 5 mm. in length, is irradiated following the preliminary technique described above. If a so-called silver tube containing radon is to be used at a desired distance of 3.50 mm. from the dorsal surface of the tail, the distance is calculated from the center of the cross-section diameter of the silver tube, which is approximately at the center of the source of radiation. The thickness of the paraffin block above the tail segment would then be 2.5 mm. (0.5 mm. for one-half the internal diameter of the silver tube plus 0.5 mm. for the wall thickness, plus 2.5 mm. of paraffin, equals 3.50 mm.).

The silver tube is 16 mm. long. Its midpoint is placed on the small paraffin block directly over the center of the tail segment and at right angles to the long axis of the tail.

In the experiment about to be described silver radon tubes were used, the initial strength of which varied from 116 to 130 mc. when they were applied to a series of eight tails. The distance was 3.5 mm. and the doses varied from 10 to 250 millicurie-hours. The tails were examined each day after the treatment. Doses of 10 and 20 mc-hr. respectively resulted in no appreciable reaction up to twenty-five days when the animals were killed and the tails removed for photographing (see Nos. 11 and 10 of Fig. 4 respectively).

With a dose of 40 mc-hr. the initial reaction was a slight desquamation of the skin over the dorsal portion of the irradiated area with slight epilation. This was noted on the twelfth day post treatment. The epilation was confined to the dorsal surface and persisted until the animal was killed (see No. 9, Fig. 4). The magnification of the photograph is not sufficiently great to show the epilation.

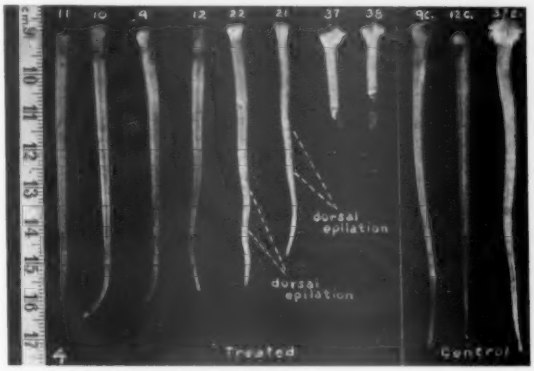

Fig. 4. Eight irradiated tails and three controls are here shown. They were removed from the respective animals twenty-five days post treatment. Treatments: 10 to 250 mc-hr. respectively; filtration 0.5 mm. silver; distance 3.25 mm.; 116 to 130 mc. of radon used. Animal No. 11 = 10 mc-hr.; No. 10 = 20 mc-hr.; No. 9 = 40 mc-hr.; Nos. 12 and 22 = 63 mc-hr. each; No. 21 = 80 mc-hr.; No. 37 = 100 mc-hr.; No. 38 = 250 mc-hr.; 9c and 12c are tails of control animals, litter mates of animals 9 to 12 inclusive, killed when the same age; 37c is a similar control for No. 37.

A dose of 63 mc-hr. was given to each of two animals, and 80 mc-hr. to another. In each instance the initial reaction was a slight dorsal epilation, noted nine days post treatment. This became more pronounced and resulted in a complete epilation of the dorsal surface of the irradiated tail segment. The tails of these three animals are shown in Nos. 12, 22 and 21 of Figure 4. Note the progressive arrest in tail length with increasing doses. The epilated areas show fairly well in Nos. 22 and 21.

A much more pronounced reaction follows as a result of an irradiation of 100 mc-hr., as shown in another treated animal, No. 37 of Figure 4. The initial reaction, desquamation and epilation over the irradiated segment, was noted at about

the same relative time post treatment as was recorded for the lower doses, yet the reaction was progressive and the tail was spontaneously amputated at the irradiated area on the eighteenth day.

An increase in dosage to 250 mc-hr. gives essentially the same result as the one just recorded, but the initial reaction was noted one day sooner and spontaneous amputation likewise occurred a day earlier, on the seventeenth day post treatment (see No. 38, Fig. 4).

Let us again consider the tissue reactions that result from placing the so-called bulb applicator directly on the surface of a segment of the mouse's tail. The glass bulb in which the radon is confined is shown at "H" of Figure 3. The steel holder in which the bulb is placed is illustrated at "I". The glass bulbs average approximately 3.5 mm. in outside diameter; so the center of the source of radiation is at approximately 1.75 mm. from the dorsal surface of the tail. The bulb touches the dorsal surface at one place very lightly. As no metal filters are used, the type of tissue reaction that results is mainly due to beta radiation.

In the experiment about to be described radon bulbs were used, the initial strength of which varied from approximately 5 to over 500 mc.[1] when they were applied to a series of 51 tails. The doses varied from 5 to 404 mc-min. Doses of 5 and 5.5 and 25 mc-min. respectively gave no apparent reaction. One dose of 30 mc-min. resulted in a temporary epilation, mainly of the dorsal surface of the tail. The center of the epilated area was immediately adjacent to the point of application of the radon bulb. For a graphic representation of this experiment see Figure 5, also Table 1.

A dose of 50 mc-min. is apparently close to the threshold dosage between temporary and permanent dorsal epilation. We have now apparently reached a plateau on what might be called the reaction curve, as is shown in Figure 5. Doses from 50 to 75 mc-min. give approximately the same tissue reaction, permanent dorsal epilation, over a period of thirty-seven days post treatment, at which time the observations were terminated. The uniformity in reaction was surprisingly regular. Given the details of the experimental set-up, type of applicator, distance factor, etc., one can predict from an examination of the treated tails alone that the treatments had ranged over a definite span of the reaction curve.

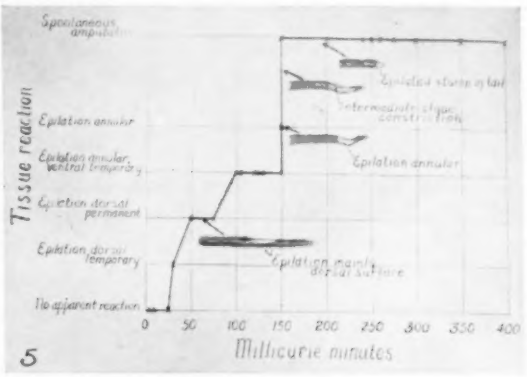

FIG. 5. This is a graphic presentation of the tissue reactions to radiation as shown in an irradiated segment of the tail of a young mouse. Applicator used—radon bulb directly on dorsal surface of a 5 mm. segment of the tail. No filter used. X. Dosages tested; for number of animals in each group, see Table 1. The sketches show typical reactions of the tails for various locations on the curve.

Doses between 50 and 75 mc-min. do not sufficiently irradiate the tail to cause an epilation of the ventral surface of the treated segment. A sketch of the side view of this tail reaction is shown in the lower drawing in Figure 5. This type of reaction is to be expected, because the tissue response resulted largely from beta-ray radiation, which was mainly employed in this particular experiment. Quimby[1] has shown that approximately 84 per cent of the beta-ray activity is absorbed by 2 mm. of tissue. Also as the source of radiation was close to the dorsal surface of the tail, even the slight difference in distance of the dorsal and ventral tail surfaces respectively from the center of the source of radiation, resulted in the ventral surface receiving less effective irradiation than the dorsal surface.

TABLE 1

Summary showing the serial number of the mouse, the dosage in mc-min., and the tissue reaction following the mainly beta-ray radiation from unfiltered radon bulb placed directly on the dorsal surface of a segment of the tail of a young mouse.[1]

Number of Animals	Dosage mc-min.	Tissue Reaction
1	5.0	No apparent reaction.
2	5.5	No apparent reaction.
3	25.0	No apparent reaction.
4	25.0	No apparent reaction.
5	30.0	Temporary dorsal epilation.
6	50.0	Permanent dorsal epilation.
7	50.0	Permanent dorsal epilation.
8	50.0	Permanent dorsal epilation.
9	50.0	Permanent dorsal epilation.
10	50.0	Permanent dorsal epilation.
11	75.0	Permanent dorsal epilation.
12	75.0	Permanent dorsal epilation.
13	75.0	Permanent dorsal epilation.
14	75.0	Permanent dorsal epilation.
15	100.0	Annular epilation, ventral-temporary.
16	100.0	Annular epilation, ventral-temporary.
17	100.0	Annular epilation, ventral-temporary.
18	100.0	Annular epilation, ventral-temporary.
19	102.0	Annular epilation, ventral-temporary.
20	121.0	Annular epilation, ventral-temporary.
21	125.0	Annular epilation, ventral-temporary.
22	130.0	Annular epilation, ventral-temporary.
23	150.0	Annular epilation, ventral-temporary.
24	150.0	Annular epilation, ventral-temporary.
25	150.0	Annular epilation, ventral-temporary.
26	150.0	Annular epilation, ventral-temporary.
27	150.0	Annular epilation, ventral-temporary.
28	150.0	Annular epilation, ventral-temporary.
29	150.0	Annular epilation, ventral-temporary.
30	150.0	Annular epilation, ventral-temporary.
31	150.0	Permanent annular epilation.
32	150.0	Permanent annular epilation.
33	150.0	Permanent annular epilation.
34	150.0	Permanent annular epilation.
35	150.0	Permanent annular epilation.
36	150.0	Permanent annular epilation.
37	150.0	Permanent annular epilation.
38	150.0	Spontaneous amputation.
39	150.0	Spontaneous amputation.
40	200.0	Spontaneous amputation.
41	200.0	Spontaneous amputation.
42	240.0	Spontaneous amputation.
43	240.0	Spontaneous amputation.
44	250.0	Spontaneous amputation.
45	260.0	Spontaneous amputation.
46	275.0	Spontaneous amputation.
47	300.0	Spontaneous amputation.
48	300.0	Spontaneous amputation.
49	350.0	Spontaneous amputation.
50	404.0	Spontaneous amputation.
51	404.0	Spontaneous amputation.

[1] It is interesting that this wide range of intensities gives apparently essentially similar reactions. We are studying this phase of the problem in greater detail with an additional number of observations. There are too few observations at the lower dosages at the present time. When still more data are obtained at the critical threshold dosages it is possible that intensity differences may be found to modify the results.

When the dosage is increased from 100 to nearly 150 mc-min. the reaction curve rises to another plateau. At 100 mc-min., in addition to the permanent dorsal epilation reaction noted for the lower doses, there was a temporary epilation of the ventral surface as well. This tissue reaction is specified in Figure 5 as "annular epilation with temporary epilation of the ventral surface."

The dose of 150 mc-min. represents a critical point in the reaction curve of this particular experiment. Eight tails treated with this dose showed temporary annular epilation on the ventral surface. Seven other tails treated with the same dosage showed complete, permanent, annular epilation. This tissue reaction marks another point on the reaction curve. Two other tails were still more severely affected by this same dosage and were spontaneously amputated fifteen and twenty-four days post treatment respectively.

In the 12 instances tested, doses of 200 mc-min. and over invariably resulted in the spontaneous amputation of the tail at the irradiated segment.

SUMMARY OF CHANGES THAT OCCUR AS A RESULT OF EXPOSURE TO VARIOUS TYPES OF RADIATION

The following reactions are given in sequence of time of appearance after treatment, but they do not necessarily all appear after every exposure:

1. Erythema: Occasionally noted in gamma and roentgen radiation, but found uniformly as an initial reaction to strong beta radiation.
2. Slight dorsal epilation of tail segment.
3. Slight epilation all surfaces of tail segment.
4. Epilation and desquamation, dorsal surface.
5. Ulceration.
6. Temporary epilation: This reaction usually follows moderate gamma radiation.
7. Permanent epilation.
   (*a*) Dorsal only.
   (*b*) All surfaces.

8. Constriction of tail at irradiated segment with epilation.

9. Dry gangrene of tail from irradiated segment to distal end.

10. Spontaneous amputation of tail.

ADVANTAGE OF A GRADED BIOLOGICAL INDICATOR IN DETERMINING MORE CLOSELY THE REACTION THRESHOLD

It seems to us that the reaction of the tail segment of a young mouse as recorded in this paper, affords a fairly accurate guide in estimating the biological response to irradiation, and it certainly is a type of indicator more nearly applicable to comparison with clinical studies of this nature. The divisions on the scale, as it were, are more finely divided.

It is possible to deliver a dose, by the methods we have employed, that will produce an epilation of just the dorsal surface of the tail, or if a stronger and more heavily filtered dose is given, an epilation effect which covers the entire irradiated segment. There is a plateau in the reaction curve which corresponds to a range of doses which will produce either one of the types of reaction just mentioned. One can use dosages as experimental measures at either end of this plateau.

At the end of the plateau representing the reaction to the stronger dosages a slight increase in the dose will lead from an epilation reaction to a spontaneous amputation of the tail. There is apparently a critical threshold point where the tissues of the tail can tolerate no further increase in the dosage, and this probably is correlated with a breakdown in the circulatory supply.

The experiments we have just recorded were taken merely to illustrate the general usefulness of the new biological measure we are using in this type of study. We have found the method well adapted to an experimental study of the effect of varying the distance, filtration, intensity of irradiation either from radium or roentgen radiation, etc. The experiments are still in the course of study and will be reported at a later date.

CONCLUSIONS

1. A 5 to 7 millimeter segment of the tail of a young mouse (approximately 9 to 12 cubic millimeters of tissue) can be used to advantage as a measure of the biological effects of irradiation.

2. The degree of irradiation effect may be measured in terms of epilation disturbance, in retardation in the growth of the tail, or in the spontaneous amputation reaction.

REFERENCE

1. QUIMBY, E. H. Comparison of different metallic filters used in radium therapy. AM. J. ROENTGENOL. & RAD. THERAPY, 1925, *13*, 330–342.

DISCUSSION

DR. H. J. ULLMANN, Santa Barbara, Calif. This paper covers, as Dr. Bagg said, quite a large field. I hope that he will correlate these reactions with the human skin erythema dose of radium and also with the roentgen-ray skin dose, thus making the method clinically useful. Dr. Bagg spoke of extending the exposure over a period of two weeks. This would hardly parallel clinical practice, for it would be practically equivalent to ten months on man. One hour on a mouse is equivalent to from twenty to twenty-five hours on a human being. I think this should be taken into consideration, and I wish to ask Dr. Bagg whether they have considered it or are going to do so.

DR. W. S. NEWCOMET, Philadelphia. This paper is interesting to me because last year I saw a child who had been irradiated for sarcoma of the hip at the age of about three or four. She is now about seventeen and one side of her pelvis and one leg shows a growth of four or five years, while the other side of the leg and the remaining portion of the pelvis shows normal development.

This paper is also interesting in connection with angioma. I have seen a number of cases that were treated and have seen the patients afterward. These children are treated at an early age and the pictures show splendid results a year or so afterward. The lips seem well balanced and in good condition at that time, but I have seen two patients after they had reached the age of seventeen or eighteen and

then the lips looked very bad because of tremendous atrophy over the treated area. At first I was inclined to think that this was due to the fact that all the tissue was adenomatous, and not until I saw the hip case did I realize the enormous atrophy that must follow radiation therapy after the patients begin to grow.

Dr. E. H. Skinner, Kansas City, Mo. I think it would be well to add a testimony upon the same complication mentioned by Dr. Newcomet.

I believe it behooves us to be extremely careful with radium therapy before the body has achieved growth. I attack these angiomata of the face and chest with great hesitancy, only repeating treatments at intervals of six months to one year, because of the atrophy that will follow. I had a case presented some years ago of a young girl with a lump in the breast. The surgeon advised radium therapy but I refused to give it because I realized that when the girl was grown there would be asymmetry of the breasts, and they would not congratulate me on having the growth controlled by radiation. I think we should be very careful of any therapy that has an influence on growing tissue even though it may be relieving temporarily a lesion which is unsightly.

Dr. Bagg (closing). Dr. Ullmann brought up the question of correlating our work with the skin erythema dosage. We intend to do that and will take the matter up. We were interested in the prolonged dosage Dr. Ullmann spoke of, and intend to see the comparative reactions. We will have to consider the question of one to twenty-five in comparing the mouse with the human in reaction to radiation.

I was particularly interested that the last two speakers mentioned the question of tissue reaction compared with the age of the patient. That was one reason we wished to use an indicator of mammalian origin, for we think that has advantage over the use of invertebrate material.

BLOOD CHANGES IN THE LEUCEMIAS AND THE LYMPHOMATA AND THEIR BEARING ON ROENTGEN THERAPY*

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ANN ARBOR, MICHIGAN

CERTAIN questions in connection with the effect of roentgen rays on the blood, especially with reference to leucemia and diseases of the blood-forming organs (bone marrow, lymphatic tissue) have come up frequently and the answers have been either vague or contradictory. Is anemia a contraindication to roentgen therapy; are small doses repeated at many intervals better or worse than large doses at one time; is a low leucocyte count a contraindication to roentgen therapy; what significance does the total number of leucocytes or blood platelets have; what data can be derived from the study of the types of red or white blood cells (differential count); what is the difference in the blood in a leucemia patient who responds to treatment and one who does not; what other aids are there in controlling the application of roentgen therapy in the treatment of diseases of the blood and blood-forming organs; what clue does the peripheral blood count give to the state of the blood-forming and blood-destroying organs?

To answer these questions and to understand the action of roentgen rays on the blood, it is important to review the development of the blood cells, their mode and place of growth and maturation, and their fate.

MATERIAL

The conclusions in the present paper are based on a study of the patients themselves or the records of 155 cases of lymphatic leucemia, 166 cases of myelogenous leucemia, 477 cases of lymphoblastoma studied at the Huntington Memorial Hospital of Harvard University, Boston,[9,10,11,12] and the study of 55 patients with various types of leucemia and 25 with lymphoblastoma at the University Hospital and the Simpson Memorial Institute at Ann Arbor, Michigan. The former (Boston) groups were treated on the basis of the maximum desirable dose of roentgen rays within three or four days, whereas the latter (Ann Arbor) group was treated by various methods, many patients receiving comparatively small doses repeated at certain intervals.

Blood studies were made before and after treatment, occasionally with many observations at short intervals, taken over long periods of time. Early changes are often overlooked if the blood is not studied before and soon after exposure.

BONE MARROW LEUCOCYTES. POLYMORPHONUCLEAR CELLS

Of the cells which grow in the bone marrow, the youngest stage seen in the blood under pathologic conditions is the primitive myeloblast (Fig. 1). In the bone marrow this is a small cell, slightly larger than a red blood cell and resembles a lymphocyte in certain superficial aspects. This cell normally grows larger and becomes a myeloblast. The next stage is the myelocyte, the largest cell of the series. The myelocyte shrinks and forms the metamyelocyte, and as the shrinking process continues, the nucleus becomes indented, and finally distinct lobes appear and the cell is a polymorphonuclear leucocyte (Fig. 1). The myeloblasts and primitive myeloblasts have the power to divide and produce new myeloblasts, or to mature and produce adult polymorphonuclear leu-

* Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23-26, 1930.

cocytes. When any cell of the bone marrow is stimulated it does one of two things: it may divide and reproduce rapidly (myeloblasts and primitive myeloblasts) or it may run through the rest of the stages of maturation and become an adult cell. When a person is exposed to roentgen rays, his myeloblasts reproduce more myeloblasts (an undesirable effect) and his myelocytes mature to polymorphonuclear leucocytes (a desirable effect). This is readily seen when careful blood studies are made at frequent intervals before and after roentgen treatment.

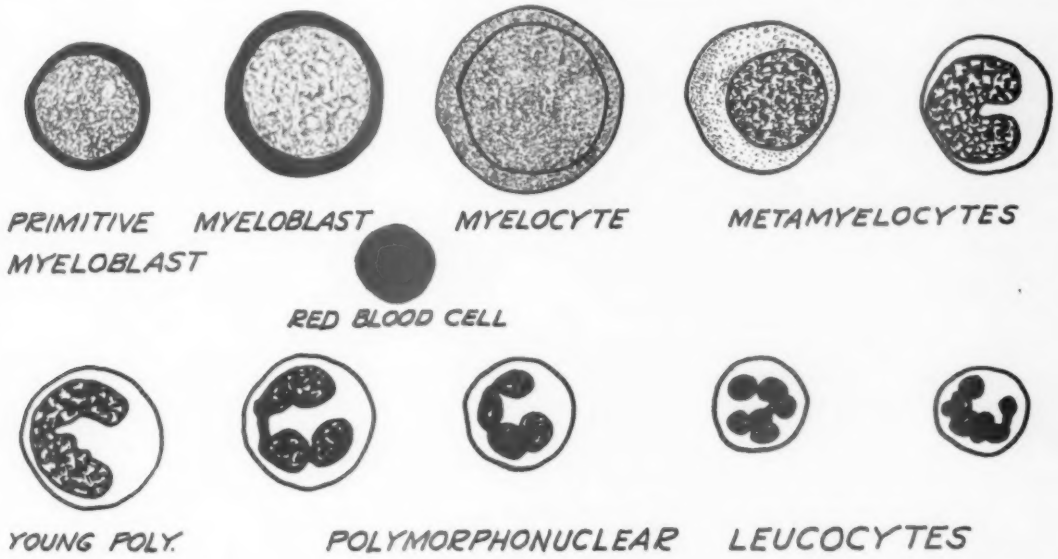

Fig. 1. Stages in the development of the polymorphonuclear leucocyte. Drawn on the same scale, from the blood of a patient with chronic myelogenous leucemia. A red blood cell is shown to indicate the relative sizes.

In chronic myelogenous leucemia there is a delay in the maturation process, and cells enter the blood stream or accumulate in the peripheral organs in an immature state. In acute myelogenous leucemia, and in the terminal stages of chronic myelogenous leucemia, the bulk of the cells are in the myeloblast and primitive myeloblast stages.

MODE OF ACTION OF ROENTGEN RAYS

While it has generally been considered that "small doses stimulate and large doses depress," in reality, all doses are stimulating, the larger doses, however, causing such a rapid rate of growth that the normal end is soon reached, and the cellular activities then appear to be "depressed." The maturation stimulating effect of roentgen irradiation is shown in several ways. Young cells stained, while living, with Janus green and neutral red, show more granules stained with the former than with the latter. In older cells the neutral red granules predominate. In cells exposed to roentgen rays, and stained supravitally with Janus green and neutral red, the granules stained with the latter dye increase in number and the Janus green granules decrease.[16] This indicates that the cells grow older rapidly when exposed to the effects of radiation therapy.

A second phenomenon which indicates that the effect of roentgen irradiation is to cause the blood cells to mature and to die of senility or be disposed of as mature cells normally are, instead of being "killed" by the therapy, is shown in the evidence obtained from a study of the saliva. Normally when a polymorphonuclear leucocyte matures and runs through its life course it

reaches the capillaries of the mucous membranes of the gastrointestinal tract, especially the mouth, and works its way through the lining into the mouth cavity by its own powers of locomotion.[6] The myeloblasts and myelocytes cannot do this, so they accumulate in the blood stream, when, under abnormal conditions as in myelogenous leucemia, they enter the peripheral circulation, and they are removed only when they mature or die. As soon as a myelocyte matures into a metamyelocyte and young polymorphonuclear leucocyte it has the power of invading the mucous membrane (diapedesis, leucopedesis). In a normal person about 5 to 150 leucocytes per cubic millimeter are washed up by the saliva as it bathes the mucous membranes.[6] After roentgen therapy (cancer; leucemia; normal animals) the number increases in the saliva, reaching 10,000 per cubic millimeter or more, especially in chronic myelogenous leucemia.[6] This indicates that following the treatment, increased numbers of immature cells are stimulated to become mature enough to wander through the mucous membranes. There is first an increase in the blood count after therapy, then the number of cells decreases in the peripheral circulation, and the white blood cell count approaches nearer normal, with a decrease in the number of immature cells (myelocytes and metamyelocytes).[14] However the number of myeloblasts may not be reduced, and at times is increased. They have not been stimulated to mature, but to divide and reproduce. This may not be evident in the peripheral circulation, because the myeloblast is an abnormal cell in the blood stream, but it is well shown in studies of the bone marrow, where the myeloblasts grow. The number of mitotic figures in dividing cells increases in the bone marrow in the twelve to twenty-four hours after irradiation and decreases rapidly after this.[15] The myeloblasts may fill the bone marrow spaces and crowd out all other cells. When the bulk of the cells are in this state in the bone marrow, the patient is said to be refractory to roentgen therapy, because these cells cannot be stimulated to mature and be lost from the body as are the adult cells. The roentgen radiation, however, does not kill them, but stimulates further growth. When small doses are applied over very long periods, the number of germinating cells decreases and aplastic anemia develops. This is always preceded by a period of hyperplasia in which the cells have been stimulated to abnormal growth until the marrow becomes "exhausted."

The stimulation of maturation of the white blood cells is further shown by a study of the age of polymorphonuclear leucocytes in the peripheral circulation. The youngest cells have a single round nucleus; in the older stage it is a band form, which becomes constricted into two lobes, then 3, 4, 5, 6 or more lobes (Fig. 1). When these types of cells are stimulated to grow older, the number of lobes in the nucleus increases. Kennedy and Grover[7] have shown that after roentgen irradiation of normal rabbits, the number of cells with one lobe reaches its maximum in $3\frac{1}{4}$ hours, those with 2 lobes reach their maximum in one to two days; with 3 lobes in four to five days; with 4 lobes in six to seven days and with 5 lobes and more after this. In other words, within $3\frac{1}{4}$ hours after therapy, the number of myelocytes maturing into metamyelocytes begins to increase, and the process continues throughout the rest of the developmental cycle during the following days.

A careful study of the kinds of polymorphonuclear leucocytes during the first fourteen hours after roentgen irradiation shows that the number of one-lobed cells increases very rapidly, starting during the first hour, and the number, which reaches its maximum in $3\frac{1}{4}$ hours, remains elevated, with but slight decrease, during the first fourteen hours. In contrast to this the number with 2 lobes decreases slowly but definitely, and the number with 3, 4 and more lobes decreases abruptly and markedly during the first hour.[7] The reason for this

is evident. The powers of movement through the mucous membranes (leucopedesis) of the one-lobed cells is feeble compared to the others[6] and they do not appear in great numbers in the mouth; those with 2 lobes can move more rapidly, whereas those with 3 or more lobes have very active powers of locomotion and quickly migrate from the circulation.

RED BLOOD CELLS

A similar maturation process takes place in the red blood cells. The youngest red blood cell is a nucleated form, normally confined to the bone marrow. This matures into the reticulocyte stage, then to the granule stage, then the mature erythrocyte

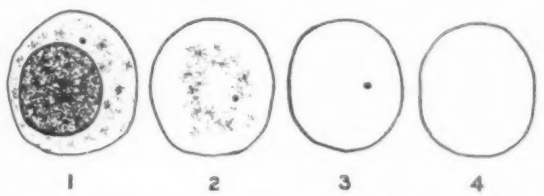

Fig. 2. Stages in the development of the red blood cell. 1. Nucleated cell (normoblast). 2. Reticulocyte. 3. Granule cell. 4. Mature cell.

(Fig. 2). Immediately (less than ½ hour) after adequate roentgen therapy the number of granule red blood cells increases, showing that reticulocytes have been

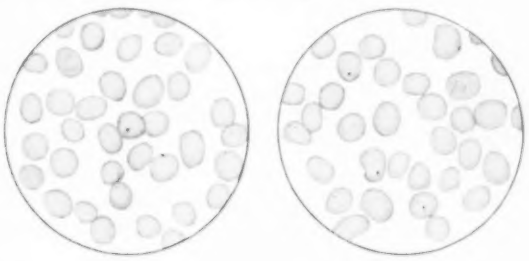

Fig. 3. Red blood cells before and immediately after irradiation in a patient with lymphoblastoma. The first field shows one granule red blood cell. The second field shows the increase in the number of granule red blood cells.

matured to the next older stage (Fig. 3). Then the reticulocytes increase, showing that the nucleated cells have been stimulated to mature quickly to the reticulocyte stage. As days pass on the reticulocytes decrease in number and mature into the granule red blood cell stage, and the number of the latter again rises. Then the number of mature cells increases. When the number of granule cells increases during the first twenty-four hours and remains elevated, it is evidence that the bone marrow contained numerous red blood cells in the reticulocyte stage, and was therefore not aplastic, and was favorably affected. One could then predict that the therapy would be effective.[5] This is well shown by a study of patients with cancer, leucemia and lymphoblastoma, as well as the ability to induce a remission in pernicious anemia or improvement in other anemias with roentgen irradiation (Minot and Lee,[13] and others).[1,3,4,19,20] Pernicious anemia is characterized by gross immaturity of the red blood cells in the bone marrow, and the stimulus of the roentgen ray makes the cells mature. (The ease of production of a remission, however, with liver or dried stomach, makes the use of the roentgen ray, as a therapeutic measure in this disease, uneconomical and primarily of academic interest at present.)

LYMPHOCYTES

Similar evidence may be gathered from a study of the lymphocytes. The youngest stage reaching the peripheral circulation under pathologic conditions is the primitive lymphoblast (Fig. 4), which resembles the primitive myeloblast closely in its appearance and its behavior to roentgen irradiation. The cell normally is confined to the lymphoid tissue and during normal life matures into the lymphoblast, then the large lymphocyte, then the medium sized and finally the adult small lymphocyte (Fig. 4). Exposure to roentgen radiation during the primitive lymphoblast and lymphoblast stages, causes the cells to reproduce with the rapid production of additional primitive lymphoblasts. As the bulk of the cells are in this stage in acute lymphatic leucemia and the terminal stage of chronic lymphatic leucemia, roentgen

irradiation does not lower the white blood cell count appreciably, and frequently aggravates the condition. When the bulk of the cells are medium or small sized lymphocytes, roentgen irradiation stimulates them to grow old, and they are exgiven within four days, this effect is reduced to a minimum, as the dividing cells do not have the same opportunity to mature enough so as to be ready for a second division within that time. Therefore, it would seem advisable to expose the pa-

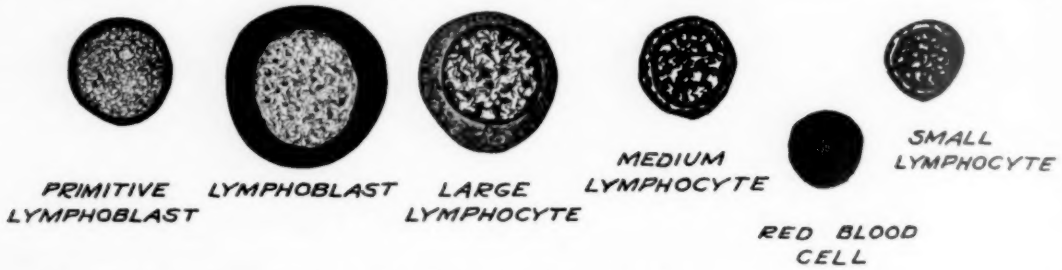

Fig. 4. Stages in the development of the lymphocyte. Drawn on the same scale, from the blood of a patient with chronic lymphatic leucemia. A red blood cell is shown to indicate the relative sizes.

creted into the gastrointestinal tract (Isaacs and Danielian,[6] Bunting and Huston[2]). Therefore, the quickest response in reduction of the white blood cell count after adequate therapy comes when the bulk of the cells are small and medium sized (*i.e.*, relatively mature) lymphocytes, and the response is but slight when the bulk of the cells are large lymphocytes and lymphoblasts. The stimulation of young stages to grow older results in an initial increase in the number of lymphocytes in the blood stream before the decrease starts. This is best seen when very small doses have been used.[17,18]

The monocytes, especially as seen in monocytic leucemia go through a similar process of stimulation and development although at a much slower rate.

FREQUENCY OF TREATMENT

It is thus evident that every exposure of the patient to roentgen radiation stimulates the "blast" cells to reproduce and the older cells to become senile and finish their life history in a normal and orderly manner. It is not a death by acute necrosis when adequate therapeutic doses are used. If the exposures are separated by an interval of several days, the dividing cells grow and are again made to divide when the next dose is given. If the maximum dose is tient to the rays as few times as possible, as every additional exposure increases the growth of the "blast" cells and hastens the time which every patient reaches, in which he no longer "responds" to the therapy.

There is always a *latent period* between the time of exposure to the radiation and the therapeutic results. This period represents the length of time that it takes for a cell to mature and behave as an adult tissue, and suffer its fate. It varies with the kind of cell, and the stage of development at the time of irradiation (reticulocyte to granule red blood cell, 15 minutes; myelocyte to metamyelocyte about $3\frac{1}{4}$ hours; carcinoma of the breast cell, around two weeks; etc.) as well as with the effective dose.

Adequate radiation therapy produces great symptomatic improvement, but on the average does not prolong the life of the irradiated group as compared to a similar but non-irradiated group (Minot, Buckman and Isaacs,[9] Minot and Isaacs[10]). Of course individual patients are encountered whose life is actually prolonged by the emergency use of irradiation in removing an immediate and mechanical cause of death, *e.g.*, enlarged tissue mass. The same condition is true in the various lymphoblastomas (Minot and Isaacs).[11]

ANEMIA

The reduction in the number of red blood cells and percentage of hemoglobin in leucemia is a factor which frequently has caused some to hesitate about giving treatment. Anemia is a contraindication to treatment only when the red blood cell tissue stops growing because it is aplastic. However, if red blood cells have no room to grow because the bone marrow is crowded with leucemic or lymphoblastomatous tissue, the one hope of relieving the anemia is to clear out the foreign cells, and allow the red blood corpuscles to mature. If the bulk of the cells are myeloblasts or lymphoblasts, roentgen irradiation will not clear out the tissue; the prognosis is bad and the anemia will not be improved. In lymphatic leucemia if the hemoglobin cannot be raised above 50 per cent after adequate radiation therapy, the prognosis is bad and little symptomatic improvement can be expected.[10] Thus, it is not the anemia or the low hemoglobin which makes the treatment ineffective, but the underlying cause. Furthermore, anemia may not necessarily contraindicate treatment, but, as in chronic myelogenous leucemia, actually be an indication calling for roentgen therapy.

BLOOD PLATELETS

The same condition exactly characterizes reduction in the number of blood platelets. Reduction in number means, in the leucemias, crowding out of the platelet-forming cells (megakaryocytes). If the crowding tissue cannot be cleared away by roentgen therapy, the platelet number cannot be increased and at the same time the immobility of the foreign tissue means that roentgen therapy is futile and the prognosis is bad. However, if the foreign tissue can be cleared away, the patient will of course be improved and secondarily the platelet number will be increased because of increased space to grow. The platelets are frequently reduced in lymphatic leucemia and always in lymphoblastic and myeloblastic leucemia. They are greatly increased in number in chronic myelogenous leucemia when the platelet-forming tissue takes part in the leucemic process.

LYMPHOBLASTOMA

Hodgkin's disease is "lymphotoxic," and even in untreated patients, the lymphocytes decrease in number, both in the lymph glands and in the peripheral circulation. Roentgen irradiation hastens this process, and therefore it is wise to use it only when there is great necessity for reducing the size of a gland. If the lymphocytes, however, are removed by roentgen rays, the gland will be smaller than if the process is allowed to proceed by itself, as in the latter case there is the continued fibroblastic proliferation while the disease takes its normal course.

In lymphosarcoma the predominant cell in the glands is a lymphoid cell, probably not one of the normal stages of the lymphocyte, however. It seldom gets into the peripheral circulation in appreciable numbers, though in some cases there is a moderate increase in the number of lymphocytes. The lymphosarcoma cell itself appears to be quite susceptible to irradiation, and its changes must not be confused with those of the normal blood cells or their precursors.

DATA MODIFYING TREATMENT

The number of red or white blood cells alone is not a guide to treatment. The numerical data must be considered in connection with the condition of the patient, the size and position of enlarged glands, the subjective symptoms, the basal metabolic rate and associated signs. A high basal metabolic rate, with nervousness, sweating, fast pulse and loss of weight are definite indications for treatment even though the leucocyte count is not markedly elevated. In the absence of these symptoms in spite of a high white blood cell count, the treatment may be postponed. It must be remembered that a low leucocyte count may mean lack of production (aplasia) or increased excretion or destruction of the cells. This must be determined by

counting the cells which wander through the mucous membranes of the mouth.[6] Roentgen irradiation may be given if the leucocyte count is low and the rate of cell excretion is high, as this is an evidence of an active, cellular bone marrow. The peripheral blood count alone, then, is not a direct indication of the state of activity of the blood-forming tissues.

DOSAGE

As to the actual dosage, in general it may be said that the larger the effective dose given at one time (*i.e.* within the course of two to four days), the quicker will be the response on the part of the blood cells. There is an intermediate dosage between large and small which frequently is not very effective in inducing blood changes.[8] The small doses frequently produce the changes so slowly that many developments can be noted which may be overlooked after large doses because of their shortened duration and rapid sequence. It is wise to divide the maximum possible dose into several days' treatment so that when the proper changes in the type of blood cells are produced (not necessarily the change in the blood count) the treatments may be suspended. From the point of view of the blood cells, treatments given within four days have much the same effect as if given all at once. If a week or more elapses, the effect is that of a second treatment. For all practical purposes, roentgen rays, radon and the radioactive substances work in the same way, but the rate of response is different, depending on the actual effective dose per unit of time.

SUMMARY

Roentgen irradiation stimulates primitive myeloblasts and lymphoblasts to rapid reproduction. Myelocytes and small lymphocytes are stimulated to finish their life history and they then die or are excreted. The latent period between the exposure to irradiation and the elimination of the leucocytes represents the period of maturation and development of the individual cells to senility. The matured cells are excreted into the gastrointestinal tract (polymorphonuclear cells into the mouth, lymphocytes into the intestines). Very rapid excretion may result in a decrease in the number of cells in the peripheral circulation (leucopenia), giving the false impression of an aplastic bone marrow. Anemia may mean crowding out of red blood cell tissue by foreign cells, or it may mean actual aplasia of the bone marrow. Anemia, then, as well as leucopenia, may not necessarily be a contraindication to roentgen therapy. As the peripheral blood count does not always give a clue as to the state of the blood-forming organs, several other factors must be taken into account in considering treatment (rate of cell destruction, type of the cells, basal metabolic rate and associated symptoms and previous response to roentgen irradiation).

REFERENCES

1. BUCKY, G., and GUGGENHEIMER, H. Steigerung der Knochenmarksfunktion durch Röntgenreizdosen. *Klin. Wchnschr.*, 1922, *1*, 11–12.
2. BUNTING, C. H., and HUSTON, J. Fate of the lymphocyte. *J. Exper. M.*, 1921, *33*, 593.
3. DAZZI, A. Morphological changes of the blood, following irradiation of the splenic area, with so-called stimulating doses. *Radiol. med.*, 1924, *11*, 529–558.
4. FABERI, M. A case of severe anemia of aplastic type treated with radiotherapy. *Policlinico*, 1924, *31*, *sez. prat.*, 1229–1232.
5. ISAACS, R. Effect of roentgen ray irradiation on red blood cell production in cancer and leukemia. *Am. J. M. Sc.*, 1926, *171*, 20–37.
6. ISAACS, R., and DANIELIAN, A. C. Maintenance of leukocyte level and changes during irradiation; a study of the white blood corpuscles appearing in the saliva and their relation to those in the blood. *Am. J. M. Sc.*, 1927, *174*, 70–87.
7. KENNEDY, W. P., and GROVER, C. A. Studies on the Arneth count. VIII. The deflection of the count by x-rays. *Quart. J. Exper. Physiol.*, 1927, *18*, 79–87.
8. LOEB, L. The effects of roentgen rays and radioactive substances on living cells and tissues. *J. Cancer Research*, 1922, *7*, 229–282.
9. MINOT, G. R., BUCKMAN, T. E., and ISAACS, R. Chronic myelogenous leukemia; age incidence,

duration, and benefit derived from irradiation. *J. Am. M. Ass.*, 1924, *82*, 1489–1494.

10. Minot, G. R., and Isaacs, R. Lymphatic leukemia; age incidence, duration and benefit derived from irradiation. *Boston M. & S. J.*, 1924, *191*, 1–9.
11. Minot, G. R., and Isaacs, R. Lymphoblastoma (malignant lymphoma). Age and sex incidence, duration of disease, and the effect of roentgen-ray and radium irradiation and surgery. *J. Am. M. Ass.*, 1926, *86*, 1185–1189; 1265–1270.
12. Minot, G. R., and Isaacs, R. Lymphoblastoma; aspects concerning abdominal lesions, especially their production of early symptoms. *Am. J. M. Sc.*, 1926, *172*, 157–173.
13. Minot, G. R., and Lee, R. I. Treatment of pernicious anemia, especially by transfusion and splenectomy. *Boston M. & S. J.*, 1917, *177*, 761.
14. Minot, G. R., and Spurling, R. G. Effect on the blood of irradiation, especially short wave length roentgen-ray therapy. *Am. J. M. Sc.*, 1924, *168*, 215–241.
15. Mottram, J. C. Histological changes in the bone-marrow of rats exposed to γ radiations from radium. *Arch. Radiol. & Electroth.*, 1920, *25*, 197.
16. Prigosen, R. E. Vital staining of tumor cells after x-ray. *J. Cancer Research*, 1924, *8*, 305–316.
17. Taylor, H. D., Witherbee, W. D., and Murphy, J. B. Studies on x-ray effects. I. Destructive action on blood cells. *J. Exper. M.*, 1919, *29*, 53.
18. Thomas, M. M., Taylor, H. D., and Witherbee, W. D. Studies on x-ray effects. II. Stimulative action on the lymphocytes. *J. Exper. M.*, 1919, *29*, 75.
19. Tománek, F. Results of radium treatment of pernicious anemia. *Casop. lék. česk.*, 1924, *63*, 549–552.
20. Yousenburg, A. Roentgen therapy in blood diseases. *Vestnik. roentgen. i radiol.*, 1924, *3*, 18.

DISCUSSION

Dr. W. E. Chamberlain, San Francisco. Dr. Isaacs speaks with more assurance than I can bring to bear upon this problem. I feel doubtful upon practically every point concerning which he speaks rather dogmatically. I sometimes think that the study of the blood does not even help in prognosis, although in general, blood studies do help in giving a prognosis. They have not helped me very much in carrying on my treatment. Some years ago I became enthusiastic about very small doses, and today my rule in the treatment of these cases is to get along with as tiny doses as I possibly can get results with. I also prefer to treat them with as little frequency as possible, that is, I would rather treat them once a month than once a week or daily. But I often have to give the treatments at frequent intervals in order to keep the dose very small. A few days ago I had a case which did not respond to the small doses and I reluctantly changed to a large dose over the spleen, and immediately got a response, not just in the blood picture but in the clinical wellbeing of the patient. That has happened a number of times and perhaps is one of the reasons why I do not feel sure about any part of this problem of treating the leucemias and the lymphomata. It is often necessary to individualize the treatment where you least expect it; it is necessary to change the technique from a small dose to a large one; from a technique with frequent small treatments to one perhaps with a single large dose and a prolonged rest afterwards. I have been working with a doctor who understands the blood very well and we have not been able to develop any close relation between the appearance of the blood and the type of roentgen treatment which benefited the patient. Harm can be done with radiation therapy in some of these cases; too much treatment is certainly bad for them.

Dr. H. K. Pancoast, Philadelphia. I wish to retract a statement made this afternoon. I said there had been no advances in the treatment of the leucemias since the early cases treated back in 1902 and 1903, with a few exceptions. The advances that we have been hoping for are those which you have just heard about. We have realized that it is in the examination of blood that we would find reasons for changing our technique which might give better results. I feel sure we have heard good reasons for making changes in our technique in treatment of different cases. It shows that in the treatment of the leucemias and some other diseases of this type, we must have the full cooperation of the pathologist.

In a rough way we have been following out this same line of investigation in governing ourselves by the polymorphonuclear count, and when that was low we have cut down the

dosage very materially. This has been done especially in cases of aleucemic leucemia.

I would like to ask Dr. Isaacs if he can explain on the basis of what he has told us, the action of the small doses of roentgen rays that seem to be beneficial in so many cases of agranulocytic angina.

DR. CHARLES GOOSMAN, Cincinnati, Ohio. I wish to ask Dr. Isaacs to explain briefly how they count the salivary corpuscles. I would also like to ask whether he has seen or followed cases of leucemia until they do not respond to roentgen irradiation. As we all know, they reach such a stage. At that stage, does the blood change explain the lack of roentgen response?

DR. G. E. PFAHLER, Philadelphia. I would like to ask Dr. Isaacs what the dosage has been in these instances in which he saw a stimulation of the development of the various cells and before this stimulation proved to be in these cells. It is new in our experience and in the various experimental records of all kinds of tissues and all kinds of living substances that have been treated. We do not get in other things a stimulating effect, a true stimulating effect. I am anxious to know what this evidence has been and how it has been proved.

DR. ISAACS (closing). A number of puzzling points have been brought up. Evidently this subject is one full of controversy. Why should small doses sometimes cure and large doses make worse? It depends on the predominant stage of the cells in the bone marrow or the lymph nodes, not on the predominant stage in the blood stream. Sometimes in Hodgkin's disease or lymphosarcoma it is impossible to tell from the blood stream the condition in the bone marrow. Therefore we must use other aids such as basal metabolic rate, the pulse rate, loss of weight, the patient's general well-being.

The method of counting the cells in the saliva is very simple. The patient is told to clear out his mouth by swallowing all the saliva which is present. He is then asked to open his mouth and allow saliva to accumulate, which happens very quickly. A white blood cell counting pipette or any kind of glass tube is inserted beneath the sides of the tongue and a drop of fluid obtained. This fluid will contain the white blood cells which have wandered through the mucous membranes of the mouth by the process of ameboid movement. This fluid is then put under the cover glass of a blood counting slide and the cells counted. Normally there are between 5 and 150 cells per cubic millimeter. After roentgen treatment or any treatment which stimulates cells to mature, mature cells come into the saliva. If you make very careful counts of the stages of the white blood cells and the red blood cells after roentgen treatment, it will be seen that the first stage is an increase in the number of mature cells or more mature cells than the blood stream showed. Immediately after roentgen treatment there may be an increase in the number of myelocytes for a few hours on the first day after treatment, a few myeloblasts having matured. Many polymorphonuclears have matured from the myelocytes. In other words, you can actually count the cells and study the process of cells getting more mature. You do not kill cells with roentgen rays; you give the treatment and then wait for results. This period in the blood corresponds to the length of time for the predominant cells to mature. Many a patient has been treated a long time and failed to respond. In that case the cells are mostly in the stage of lymphoblasts or myeloblasts.

DR. F. B. STEPHENSON, Denver, Colo. Do we understand that roentgen treatment of a normal person will cause the same increase of cells in the saliva?

DR. ISAACS. I haven't treated a normal person. In patients with cancer or some small growths elsewhere in the body, the effect is exactly the same. Any condition which stimulates cells to get ripe, will cause an increase in the number of cells in the saliva.

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THE ROENTGEN TREATMENT OF METASTASIS TO THE VERTEBRAE AND THE BONES OF THE PELVIS FROM CARCINOMA OF THE BREAST*

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INCIDENCE

SKELETAL metastasis from carcinoma of the breast is a manifestation of the terminal generalization of the disease, and, therefore, its incidence should approach 100 per cent. However, from the literature the exact percentage is difficult to determine. It is obvious that at necropsy many cases are missed unless there is some indication for examination of the vertebral and pelvic bones, and even then metastasis that has not produced gross destruction of bone will not necessarily be discovered. Clinicians naturally diagnose only those cases in which symptoms are severe enough to warrant a definite opinion that a lesion of bone is present.

Handley, in 329 necropsies at the Middlesex Hospital in cases of carcinoma of the breast, found involvement of bone in 73 cases, an incidence of 22 per cent. Risley found about 25 per cent. Giles stated that there is metastasis to bone in an average of 30 per cent; in Kaufmann's[49,50] series the incidence was 53 per cent; in Snow's small series of unselected cases it was 73 per cent, and in Ginsburg's[32,33] series of cases studied at the Montefiore Hospital the incidence was about 75 per cent. Ingraham and Kitain asserted that osseous metastasis occurs more commonly than available statistics lead one to believe. One might suspect that the percentage-incidence varies in proportion to the thoroughness with which one examines patients for metastasis to bone; or else the great discrepancy in these figures may depend on the types of cases studied.

The fact that carcinoma of the breast may metastasize early is not taken seriously enough in clinical practice, for the spine and pelvis may be the seat of trouble for a long time without other lesions, and without symptoms or apparent change in the patient's condition. The high incidence of skeletal metastasis makes it an important problem for the pathologist, the internist, and the radiologist, because carcinoma of the breast is one of the commonest forms of malignant disease, and its mortality rate is apparently still on the increase. In many cases in which the bone is involved the patients suffer from severe symptoms for months before they finally succumb to the ravages of the disease, or to intercurrent infection. The general opinion is that treatment in such an advanced stage of the carcinoma is useless, since osseous metastasis is highly resistant to roentgen therapy.

The value of roentgen therapy for skeletal metastasis is difficult to determine, because, notwithstanding its frequency, few systematic studies of treatment have been made. Most papers deal with the pathologic or roentgenographic phases of the subject; clinical reports of one or two cases are frequent, generalizations are commonly made from insufficient evidence, and diametrically opposed statements are common. In many reports the number of definitely diagnosed cases is uncertain, and the technique is not described or is stated ambiguously. Some authors aver that roentgen therapy for metastasis to bone is not only useless, but dangerous, while others as positively state that treatment of such lesions gives brilliant results, and that osseous metastasis is the most fruitful field in inoperable carcinoma for treatment.

* Read at the Thirtieth Annual Meeting, American Roentgen Ray Society, New York City, Sept. 17–20, 1929.

My study of the subject was initiated in an endeavor to obtain definite information of the value of roentgen therapy.

PATHOLOGY

Why carcinoma of the breast should so frequently metastasize to the vertebral and pelvic bones is not known. Handley stated that the liability of bone to metastatic invasion increases with its proximity to the site of the primary growth. In contradiction to this is the fact that many observers, such as Mueller, Schlesinger, Kaufmann,[49,50] Lee and Herendeen, Lee and Tannenbaum, and Buday, found the spinal column involved most frequently, then the pelvis, then the upper part of the arm, then the ribs, and then the skull. Occasionally a primary tumor had not been found clinically, and yet symptoms of metastasis were manifest. Other authors, such as Helly, Risley, Matthews, Ritchie and Stewart, and Belot and Lepennetier, stated that the possibility of metastasis stands in close relationship to the histologic structure and spatial extent of the primary tumor; that the greater its local growth, the less likely it is to metastasize, and that the greatest incidence of metastasis to bone is noted in scirrhous carcinoma.

MECHANISM OF METASTASIS

The mechanism by which malignant cells are carried to the vertebral and pelvic bones is still the subject of controversy. Handley contends that "it results from far extension of the primary growth along the deep fascial lymphatic plexus." He apparently showed that carcinoma of the breast often invades the epigastric node, and from there reaches the lumbar lymph nodes and the lumbar vertebrae by secondary embolic infection from other abdominal metastatic deposits in the later stage of the disease, and by gravitation of particles of carcinoma into the pelvis, and their subsequent implantation on one or the other of the pelvic organs. Joll opposed this conception and stated: "It appears to me that the evidence is preponderatingly in favor of the claim that bone metastases are blood borne, and that they are due to the lodgement of malignant emboli in the bone marrow. If we accept the lymphatic permeation theory of the origin of these secondary growths how can we explain a femoral deposit from carcinoma of the tongue, a metastasis in the humerus from carcinoma of the rectum, a secondary growth in the radius from a primary in the bladder unless, indeed, we regard these all as exceptional, or alternately, consider that the breast metastasizes differently from all other tumors?" The lymphatic permeation theory of Handley is accepted by Simpson, Deaver, Carnett, and most surgeons who have written on carcinoma of the breast. Opposing this view, Levin asked for an explanation of how distant metastasis can take place without local recurrence after operation unless the carcinoma cells were transplanted during the operation. In his textbook on carcinoma of the breast, Fitzwilliams stated: "I can only conclude by saying that after giving very careful attention to all the writings and arguments on the subject I have not met a single fact that would support the argument in favor of permeation, as everything can be explained by the far simpler method of blood borne or lymphatic emboli." Piney said that the bone marrow becomes involved by emboli in the blood stream. The bones which have red marrow, the ribs, sternum, vertebrae, and innominates, are most likely to be the seat of metastasis.

A direct, definite relationship of the bone marrow to the general lymphatic system is of greatest significance in the clinical pathology of secondary tumors from carcinoma of the breast. Lymph capillaries have been described accompanying the blood vessels in the haversian canals in bones by Klein. Nothing is known apparently concerning the lymphatics of the bone marrow. Roger and Josué stated, "Il n'existe pas de vaisseaux lymphatiques dans la moelle des os," and this view has

been accepted as final. The only experimental study was made by Piney who failed to demonstrate lymphatics in the bone marrow.

Metastasis in bone from carcinoma develops within the marrow, and when the group of carcinoma cells is small, the marrow appears normal. In his pioneer work on the subject, von Recklinghausen stated that this development is a circulatory-mechanical process. That is, the vulnerability of the skeletal system is to be ascribed to the ease with which carcinoma cells brought by the blood stream, can be retained in the capillaries of the bone marrow. The wider caliber of the capillaries of the bone marrow, the thinness of their walls, and their inclosure in a shell of bone, lead to retardation of the blood stream in the capillaries and small veins and to peripheral stagnation where the malignant cells grow and multiply. The fact that in metastatic carcinoma of bone it is easy to find veins filled with carcinoma cells, and the general opinion that the bone marrow is lacking in lymph vessels and has no relation to the general lymphatic system is the most forceful argument presented by those who accept the circulatory-mechanical theory of von Recklinghausen.

Handley was the first to assert that metastasis of carcinoma to the skeleton differs in no way from metastasis to other organs, and that the route of invasion of the metastasis is usually that of carcinomatous invasion of the lymphatic system. He expressed the view that carcinoma cells invade the bone by way of the lymph vessels entering the bone at the points of insertion of muscles. However, Kolodny, in a series of experiments, showed a direct relationship between the bone marrow and the lymphatic system, and he stated that there is no need to invoke more or less hypothetic lymph vessels entering the bone at the points of insertion of tendon. Kolodny expressed the belief that the direct relationship he demonstrated between the bone marrow and the lymphatic system provides the missing link for the anatomic basis for the lymphogenous theory of the invasion of bone by carcinoma cells.

Handley commented on the invasion of the hypogastric lymph node by carcinoma cells. This node is the regional node of the bones of the pelvis and lower extremities and invasion of it can easily lead to invasion of the pelvic bones by a retrograde flow of lymph. Since the occurrence of a retrograde flow of lymph was questioned, Kolodny carried out experiments to elucidate this point. It is well known that with carcinomatous involvement the changes in the lymph nodes frequently lead to occlusion of the efferent vessels. In the early stages of the involvement of the lymph node, carcinoma cells are found lying in the subcapsular lymph sinuses, at the point of entry of the efferent lymphatics. Later these cells compress the pulp and lead to atrophy of the lymphoid tissue and to obliteration of the node. Then the carcinoma cells invade the capsule and the peripheral vessels; obliteration of the sinuses of the node follows, causes a retrograde lymph flow, and nullifies the importance of this node as a guard against further infection. In such cases, aberrant lymph capillaries develop. These are channels for communication between the afferent and efferent vessels of the obliterated node, as has been proved experimentally. Such an aberration of the lymph stream readily explains the so-called paradoxic metastasis which occurs when carcinoma skips the regional nodes and yields distant metastasis.

Metastatic involvement of the bones of the opposite side from that of the primary tumor frequently is found. Kolodny explained this as either a case of general carcinomatosis in which the circulation is overflowing with carcinoma cells, or a case of a tumor in a more or less early stage, in which the cells are brought to the opposite side by lymph vessels that cross the median line. He showed experimentally that when the normal flow of lymph to the regional nodes of a certain part is radically

interfered with, or the regional nodes are occluded because of previous involvement, a reflux lymph flow drives the cells into adjoining regions; whether these elements are carried through an entirely new-formed system of lymph capillaries or are forced through plexuses of fine lymph capillaries is a question.

The frequent occurrence of pelvic metastasis in carcinoma of the breast is thus explainable anatomically as a result of a combination of an aberration of the lymph stream, and a reflux lymph stream. In advanced cases both circulatory systems, the blood and lymph, may be used to transport the cells in their general spread.

Metastatic carcinoma, having invaded the bone, may cause formation of individual nodules, or diffuse infiltration (as a result of which the whole spongiosa of a vertebra, or the head of the femur, may be filled with carcinomatous tissue). Then it may grow along the vessels of the cortex to the surface and form nobby subperiosteal thickening, or there may be multiple diffuse regions of absorption of bone.

TYPES OF METASTASIS

It is generally accepted that there are two forms of skeletal metastasis, the osteoclastic and osteoplastic, although both forms commonly exist together. In the former, the tela ossea are resorbed, and much of the cortex is destroyed, so that the bone may fracture under the least trauma; in the latter, the tumor forms new bone substance as a result of which the bone becomes broader and heavier. In the higher grades there is a compact, finely porous substance in the spongiosa, and the superficial deposits have the same structure. Such a bone has the appearance of hyperostosis, or osteosclerosis (Aschoff).

HISTOPATHOLOGY

von Recklinghausen first made the observation that large polynuclear osteoclasts, which destroy the bone in osteoporosis, seldom are found in the lacunae of bone surrounding a growing metastatic carcinoma. This fact has been confirmed repeatedly. In view of the absence of these osteoclasts, he assumed that softening takes place in the bone by removal of inorganic salts, and that subsequent absorption takes place without the aid of special cells, a condition similar to the one found in osteomalacia. Apolant, Erbslöh, and Askanazy are also of the opinion that osteoporosis in skeletal carcinoma takes place without the aid of special cells. On the other hand, Wolff[93] and Goetsch expressed the belief that the cancer cells act as osteoclasts and destroy the compact bone. Axhausen maintained that the small, elongated, mononuclear connective tissue cells frequently found close to the walls of the lacunae, are special osteoclasts derived from the stroma of the carcinoma. But even if this were true the tumor itself first destroys the bone and then grows by occupying the space it has produced. von Recklinghausen claimed that such extensive formation of new bone is due to hyperemia and hemostasis from obstruction of the capillaries by endovascular tumor emboli. Courvoisier and Kaufmann[49,50] maintained that a metastatic deposit in bone is always surrounded by a zone of inflammation, and that this causes the sclerosis. Askanazy expressed the belief that the metastasis at first produces osteoporosis, which is followed by necrosis of bone, and that such necrotic bone acts as a foreign body to produce new bone. Wolff,[92] Courvoisier, and Kaufmann hold that carcinoma cells may act as osteoblasts and form new bone. In his series of cases Helly did not mention lymphocytic infiltration. Levin did not find hyperemia, inflammation, or other abnormality, and agreed with Axhausen, Schmorl, and Mueller that some chemical irritant emanating from the carcinoma cells acts on bone and stimulates its proliferation.

That skeletal metastasis gives rise to marked inflammatory reactions of noninfectious origin, has been recognized since 1886 when Lanzinger wrote about it. In 1891 von Recklinghausen advocated the

idea that it was this noninfectious inflammatory reaction that was responsible for the formation of new bone in skeletal metastasis; he was upheld in this view by many pathologists, including Askanazy, Assmann,[4] Courvoisier, Fischer-Defoy, Kaufmann and others, who also described inflammatory infiltration, but who differed on its interpretation. The histopathologic literature is replete with reports of osteoplastic metastasis, in which an inflammatory reaction was unusually prominent. In a series studied by Kaufmann,[49,50] this inflammatory reaction was so striking that he thought this form of carcinomatous metastasis fully deserved the designation "carcinomatous osteitis."

This noninfectious inflammatory reaction as a feature of osteoplastic skeletal metastasis and as a frequent accompaniment of the development of malignant neoplasms generally has been emphasized by Ewing, Goforth, and Aschoff.

Ginsburg,[32,33] in his works on metastasis to bone from carcinoma of the breast, emphasized this inflammatory reaction, but did not give it any clinical or therapeutic significance. He stated: "Although this inflammatory reaction has received much attention, study, and investigation from pathologists, histologists, and anatomists, its clinical side has been sorely neglected."

According to Handley it is this noninfectious inflammatory reaction, followed by fibrosis, that frequently is responsible for the local cure of carcinoma, or for its spontaneous recession or remission.

I shall emphasize later in this paper that such inflammatory infiltration is of considerable significance in the evaluation of radiotherapeutic results of treatment of metastasis to the vertebrae and pelvis from carcinoma of the breast.

In an attempt to evaluate the influence of roentgen therapy on metastasis to the vertebrae and bones of the pelvis, secondary to carcinoma of the breast, 40 cases in which treatment was given in the Section on Roentgen-ray Therapy, in 1925 to 1928, inclusive, were reviewed. Of these women, 20 had malignant disease of the left breast; 19, of the right breast, and one woman had carcinoma in both breasts. The age incidence was that usually given as the "cancer age," for the age of only one was less than thirty years; 6 were from thirty-one to forty years of age, 10 from forty-one to fifty, 17 from fifty-one to sixty, and 6 from sixty-one to seventy. There is, therefore, in the site of the growth and age of the patient, nothing significant in regard to incidence of metastasis to bone.

SYMPTOMS

1. *The Neuralgic Stage.* The characteristic symptom of involvement of bone, secondary to carcinoma of he breast, is pain. At the outset this pain may be mild and transitory. It may consist only in stiffness, weakness, or a "catch" in the back which the patient regards as a "cold," and which is treated with home remedies. Motion of the spinal column always intensifies the pain, and rest relieves it. As time goes on, the pain becomes more severe and more constant and the diagnosis of lumbago or sciatica is often made. Sciatica is a subject of great antiquity and corresponding vagueness. The first good description of sciatica was that by Cotugno, but the most exhaustive early report was that by Valleix, who reviewed the literature to 1840. Simonson cited some cases treated by roentgen therapy and gave the early references on the subject. The fact that in many cases the pain is referred, and is not due to actual disease or injury of the sciatic nerve is becoming more widely recognized. Seldom is there actual destruction of the nerve itself, but nearly all cases of "sciatica" of this kind can be traced to a disturbance in a nearby bone or joint to which the sciatic nerve sends a filament. However, when there is extensive involvement of the lymphatic nodes adjacent to the nerve or to branches of the lumbosacral plexus, the pain is of direct mechanical origin.

The sciatic nerve arises just above and just below the promontory of the sacrum, and is a direct continuation of the lower two lumbar and the upper three sacral nerve roots. In the pelvis the nerve is assembled from its various roots, and here it is often subject to pressure from malignant nodes. Connecting filaments link it up to the other important nerves in the vicinity. It supplies sensation to the lumbar articulations, so that involvement of the lumbar portion of the spinal column by carcinoma may express itself in pain felt down the leg. Besides this process, direct pressure from the diseased bone may cause pressure neuritis. The upper part of the nerve descends into the pelvis in front of the sacroiliac joint, supplying it. Since this joint is often involved by secondary malignant deposits from carcinoma of the breast, and since the joint is unstable in comparison with the spinal column and hip-joint, it is not hard to understand how malignant disease at this point may manifest itself by pain along the distribution of the sciatic nerve. The nerve leaves the pelvis to enter the buttock through the great sacrosciatic foramen. Involvement of the bony margins of this notch may also produce direct pressure on the nerve. As the nerve descends it lies behind the hip-joint, which it supplies. Tumors in the vicinity, or lesions in the upper part of the femur, may irritate it. In the thigh, the sciatic nerve supplies the hamstring muscles, and at times is pressed on or irritated by secondary deposits in the shaft of the femur. Usually, the sciatic nerve divides in the thigh into branches which supply all the muscles below the knee and nearly all the sensation.

Typical sciatic pain is, as a rule, rarely complained of only in the buttock. The pain does not necessarily follow the whole nerve, and may be confined even below the knee. In most cases, the exciting cause is either in the lumbar part of the spinal column, in the sacroiliac joint, or in the hip-joint, singly, or in combination, depending on the structures which malignant secondary growth has involved.

When the local remedies for rheumatism, myalgia, neuritis, neuralgia, or lumbago are of no further avail, sedatives are sometimes prescribed. When these have failed, there is the possibility that baking, diathermy, and more and stronger sedatives may be used. If the pain is still intractable (and it usually is) and if a diagnosis of hysteria or neurasthenia should be made, psychotherapy might be ordered. These failing, the patient is sometimes put into a cast. At this stage, deformity of the spinal column usually is lacking, and pressure on the spinal column does not produce pain. In spite of the severity of symptoms, the dangerous practice of massage is often carried out, usually without a roentgen examination to ascertain the possible presence of metastasis, until, suddenly, a pathologic fracture reveals the true underlying cause of the pain. The fact that the patient has had a carcinoma of the breast is often ignored or completely forgotten.

Patients may have skeletal metastasis for months without evidence of local recurrence or evidence of visceral metastasis. Cachexia is rarely noted in this group and yet carcinoma is often ruled out merely because the patient is not cachetic. The weights of 5 of the patients in this series, at the time of their first course of roentgen therapy, were 100 pounds or less; 9 were of average weight (135 pounds); 13 were stout (150 pounds); 9 were obese (170 pounds), and the weight of 4 was not recorded.

It is well to emphasize again, contrary to the prevailing opinion that the pain from the skeletal metastasis is constant, persistent and progressive, that pain in the early stage may be mild, fleeting, inconstant or indefinite. Of the 40 patients in this series, 2 complained of mild pain, 20, of severe pain, and 18, of crippling pain. The duration of the pain is shown in Table 1. The pain was usually of widespread distribution, and varied in degree from the dullest to the most acute, excruciating

TABLE I

DURATION AND SITUATION OF SCIATIC PAIN, BEFORE DIAGNOSIS OF ITS CAUSE IN 39 CASES OF METASTASIS TO BONE FROM CARCINOMA OF THE BREAST

Duration of pain, months	Cases
Less than 1	3
1 to 2	6
3 to 6	15
7 to 12	6
13 to 18	3
More than 18	3
Not stated	3
Situation of pain	
In the back only	2
Back and thighs	7
Hip and thigh	33
Left hip and thigh	2
Right hip and thigh	31
Back, hip, and thigh	21
Thigh to knee	18
Thigh to foot	6

or agonizing. Pain in these cases was the major clinical problem. Contrary to many authors who have stated that spontaneous remission of symptoms, even to complete freedom from pain, is commonly seen in metastatic carcinoma of bone, in not one of the cases reported here was such a remission of symptoms recorded before treatment. In all cases the pain had been constant, and of increasing severity at the time of treatment.

2. *Stage of Deformity and Compression.* The neuralgic stage may last a long time without palpable deformity of the bone. Later, the shape of the spinal column changes. Sometimes the spinal column may collapse as if it were made of rubber, and the patient actually may become shorter; in one of Schlesinger's cases a decrease of 8 cm. in height was noted. Often this collapse of a vertebra produces compression of the spinal cord. Also an arch-shaped kyphos or vertebral displacement may develop, much as in tuberculosis. Compression of the spinal cord often leads to motor or sensory paralysis and to vesical or gastrointestinal disturbances. The stage of compression lasts a shorter time than the neuralgic stage, for, as a rule, death occurs in a few weeks or a very few months. However, patients with extensive destruction of the spinal column or of the bones of the pelvis from secondary deposits from carcinoma of the breast may remain in fairly good condition for a long time. In cases of persistent, obstinate backache, or sciatica, one must always be on the lookout for metastasis, even though the lack of deformity may seem to contradict such a tentative diagnosis.

General examination at the time of treatment disclosed recurrence or lack of it as shown in Table II. In 38 cases, the roentgenograms of the thoracic organs were negative for metastasis, and in 2 carcinomatous spread was revealed. These facts confirm the report of Moore that the lungs and the bones are seldom involved in the same patient, and that combined visceral and osseous metastasis is infrequent.

TABLE II

RECURRENCE AFTER PRIMARY OPERATION AS NOTED AT THE TIME OF TREATMENT FOR METASTASIS

	Cases
Local recurrence	35
With involvement of thoracic wall	20
Thoracic wall only	9
Thoracic wall and axilla	3
Thoracic wall and supraclavicular space	6
Thoracic wall and both axillas and supraclavicular space	2
Without involvement of thoracic wall	15
Distant recurrence	9
Skull exclusive of orbit	3
Orbit	2
Liver	4
No recurrence	10*

* In 2 cases primary operation was too recent to allow of recurrence.

It is a fact not generally recognized that metastasis to the vertebrae and pelvic bones may take place at any time during the life history of carcinoma of the breast and not necessarily after many years. Confirmation of the usual view that metas-

Table III

PERIOD FROM DIAGNOSIS OF CARCINOMA TO ONSET OF PAIN*

Period, years	Cases
Less than 0.5	4
0.5 to 1	5
1 to 2	7
2 to 3	5
3 to 4	6
4 to 5	5
7	1
8	1
10	2
11	1
16	1

* Pain noted before tumor in 2 cases.

tasis is a late process in the evolution of the disease is indicated in Table III.

It is self-evident that roentgen therapy directed to the thorax in postoperative treatment can have no effect on malignant cells already disseminated outside the fields treated, and that it is of no avail whatever in slowing the growth of those cells already in the spinal column and bones of the pelvis. Sufficient evidence has not yet been accumulated to justify "prophylactic treatment" of the spinal column as a routine in addition to that of the other danger zones. However, from the standpoint of safety alone the possibility is worth consideration. Whether postoperative treatment keeps patients living to an age when osseous metastasis already existing at the time of operation may have a chance to manifest itself is at present an unanswerable question.

In this group of cases of osseous metastasis to the spinal column or pelvis 9 patients had had postoperative treatment by roentgen rays. The exact proportion between patients who did not have postoperative treatment and those who had or did not have skeletal metastasis subsequently was not determined, and is of no concern here as this discussion is not of the value of postoperative roentgen therapy.

Of the 40 patients, 36 were operated on for primary carcinoma of the breast: 16, at the Clinic and 20, elsewhere. Four were not operated on. Of the 16 patients who underwent operation at the Clinic, 9 received postoperative treatment by roentgen ray at the Clinic, one patient, both at the clinic and elsewhere, and 6 patients did not have any postoperative treatment. The incidence of local recurrence among the 9 patients who received postoperative treatment at the Clinic was as follows: 3 did not have local recurrence at the time of treatment for metastasis, 3 had recurrence in the skin of the thoracic wall, and 3 had supraclavicular metastasis only.

Table IV gives a detailed analysis of the condition, at primary operation, of the 16 patients operated on at the Clinic.

The statement has been made repeatedly that slowly growing scirrhous carcinoma is prone to skeletal metastasis.

Although the number of patients operated on at the Clinic whose microscopic diagnosis is definitely known (Table IV) is too small to permit of definite conclusions or to allow of generalization, there is, superficially, no relationship between the histologic character of the tumor and the incidence or type of metastasis. The statement that rapidly growing carcinoma produces a definite type of metastasis in a certain situation was not confirmed by this small group. There was no simple relationship in the cases in which operation was performed at the Clinic between the size and site of the primary breast tumor or its axillary involvement and the site and extent of its metastasis. Large groups of carcinomas of the breast must be studied at necropsy to clarify many of these points, for it is not definitely known which type of carcinoma of the breast is more likely to metastasize to bone and which to viscera, although at necropsy it has been shown that not all carcinomas originating in the breast have done both.

An exact diagnosis of vertebral or pelvic metastasis cannot be made with certainty from the history or general examination alone. The coexistence of backache and

carcinoma of the breast rather suggests that the latter is causing the symptoms. Pain may be absent when the bones are actually riddled with metastatic growths, as during the evolution of the metastatic cells pain is caused only when the periosteum is put under tension by their multiplication. When the periosteum has ruptured and the malignant cells are left free to grow extraperiosteally, pain is absent entirely or is much less severe. Clinical signs that are of assistance in making a diagnosis of malignant osteitis have been described by Risley, Schlesinger, Flatau, Oppenheimer and Ginsburg.[32,33]

Definite diagnosis is established most easily and certainly by roentgen examination. But one should always remember that metastasis may precede changes in the bones that are demonstrable in the roentgenogram, and that inflammatory osteitis may present a roentgen picture identical with that of metastasis. With a doubtful roentgenogram of the pelvis or spinal column and a previous or coexisting carcinoma of the breast, the likelihood that metastasis is present is far greater than that there is an inflammatory change in the bones in question.

The roentgen diagnosis of osseous metastasis has been fully considered in the papers by Fraenkel; Pfahler;[72] Pförringer; Schinz, Baensch and Friedl; Assmann;[5] Sicard, Belot, Coste and Gastaud; Sicard, Lermoyez and Laplane; Kienböck, and George and Leonard, and will not be enlarged on here. As one reviews the roentgenograms of the cases on which this paper is based, certain outstanding facts are disclosed. Most obvious is that the commonest site of metastasis is the region of the sacroiliac joint; next in frequency is the sacrum, then the lumbar part of the spinal column, more uncommonly the femur, and rarest of all, the pubis. In no case was there a single metastatic area in one bone as the cause of pain. Involvement of one or more vertebrae often was accompanied by areas of metastasis in the innominate bone. No one patient had

Table IV

CONDITION OF PATIENTS WHO UNDERWENT PRIMARY EXAMINATION AT THE CLINIC

Case	Age, years	Breast involved	Size of carcinoma, cm.	Report of microscopic examination	Extent of involvement of axilla
1	42	Right	Not given	Carcinoma	Graded 3
2	46	Left	2 by 3	Carcinoma	None
3	31	Left	Not given	Graded 3	Involved
4	57	Left	3.5	Small cell carcinoma	None
5	53	Left	2	Carcinoma	Graded 3
6	52	Left	3 by 2	Carcinoma	None
7	45	Right	Large	Scirrhous carcinoma	Graded 4
8	53	Left	4 by 3	Carcinoma	None
9	56	Right	7 by 4	Graded 3	Graded 2
10	34	Left	8	Carcinoma	Graded 3 or 4
11	54	Right	5	Carcinoma	Graded 2
12	53	Left	6 by 4	Adenocarcinoma, graded 4	Graded 4
13	49	Left	5 by 2.5	Carcinoma	Graded 2
14	37	Left	3	Carcinoma	None
15	58	Right	4 by 4	Carcinoma, graded 4	Graded 2
16	57	Right	4 by 3	Adenocarcinoma, graded 3	Graded 4

metastatic lesions of approximately uniform size; the variation was often from 5 mm. to 5 cm. There was no relationship between the situation of the metastasis and the microscopic structure of the primary tumor of the breast in those cases in which the structure was definitely known. This group does not confirm the observation that rapidly growing carcinoma (graded 4) produces metastasis in which destruction of bone is noted exclusively, for mixed lesions were commonest. This type of tumor did not produce the greatest number of metastatic areas, nor did it appear that metastasis is commonest from scirrhous carcinoma. There was in the group considered here no constant relationship between the structure of the primary tumor and its metastatic vertebral and pelvic lesions as far as could be determined. In brief, this study bears out the well-known dictum that "the living world knows no constants." In 2 cases, consideration of the metastasis alone did not permit differentiation of a lesion secondary to carcinoma of the breast and metastasis from a prostatic primary carcinoma. The structure of the pelvis and the sex of the patient, of course, cleared up all doubt.

There was no relationship between the situation of the largest metastatic growth, as shown in the roentgenogram of the pelvis and the result of treatment, nor between the site of the growth and the site of the pain, nor between the site of the metastasis and the degree of pain.

It is a strange clinical fact that pain from metastasis may exist in patients the roentgenographic examination of whose pelves gives negative results. This happened in 8 cases in which treatment was given but which are not included in this series and the diagnosis was "arthritis" in 3 others. The difficulty of distinguishing malignant from inflammatory arthritis and osteitis is too well known to be other than mentioned. The negative data in the 11 cases just mentioned, however, may be explained in either of two ways: (1) the pain may have been due to impingement on the pelvic sensory nerves by lymph nodes that were transparent to roentgen rays but that were involved by metastatic carcinoma, and (2) the carcinoma cells, in their growth, may not have been accompanied by a reaction which changed the density of bone, or the reaction may have been too slight to appear in the roentgenogram. Therefore, a negative roentgenogram does not exclude the possibility of metastasis as the cause of the symptoms in a given patient.

The occurrence of pain in the right hip or thigh, irrespective of the site of the metastasis shown in the roentgenogram in 31 of 40 cases in this series (2 patients had pain in the left hip only, and 7 in both hips) is too high to be mere accident or coincidence. That such a high proportion of pain does occur on the right side is a fact not mentioned in any of the works I have reviewed. The explanation of such a phenomenon is obscure and merits further neurologic investigation. The occurrence of right-sided pelvic or femoral pain in a patient who has or has had a carcinoma of the breast is a point to remember in making a differential diagnosis of osseous metastasis.

TREATMENT

Various methods of treating the pain of metastatic carcinoma of bone have been reported, but as a whole the patients who suffer from the unbearable agonies of malignant involvement of vertebrae and pelvis have been treated with analgesics and sedatives. Joll stated: "Treatment will seldom be undertaken if the true secondary nature of the tumor be recognized. It is perhaps a counsel of perfection to suggest that all bone tumors should be explored and examined microscopically before any radical operation is undertaken. As a rule the benefit to be expected from operations on secondary growth of the bones is but transitory." The combination of increasing doses of sedatives and supporting casts or braces adds but little to the comfort of the patient. Patey stated that treatment is

palliative only; sedatives, nursing, and jackets rarely give relief of pain. The control of almost intractable pain in the lumbar region, pelvis and lower extremity has been obtained by Peet through chordotomy in several cases. Some surgeons have reported success from epidural injection of the sciatic nerve (Mandl) and from ramisectomy.

Since 1907, when Freund reported treatment of a patient with probable metastasis to the pelvis from carcinoma of the breast, the excellent results (amounting in some cases, as Kelly and Fricke stated, to almost a resurrection) from roentgen therapy of osseous metastasis have been known. Strangely, this fact has not received widespread attention, for the literature contains few references to systematic studies on the subject. Matthews, in 1915, could find no record of radiotherapy of secondary malignant disease in bone. Isolated reports of benefit are common, and improvement subsequent to radiotherapy of osseous metastasis is often mentioned incidentally, although many have reported excellent results in the treatment of one to five cases. It is true that some authors have reported failures or indifferent results (Rahm, Jüngling, Flatau, Kaestle, and Carter) but as a whole they have been extremely encouraging, so much so, in fact, that Borak[11,12,13,14] stated that osseous metastasis is the most favorable field in the treatment of inoperable carcinoma. As in most fields of roentgen therapy, the technique and indications of treatment are largely individual to the therapist.

For reasons that are not at all certain, the common opinion is that metastatic carcinoma of bone is resistant to irradiation. It is surprising, therefore, in the light of such opinion, that some excellent results were obtained by moderate divided doses. Even though recent literature contains many reports of cases in which patients' conditions have been improved by high doses, the results are not so outstandingly superior as to justify the abandonment of all but intensive high voltage treatments. Some authors have reported palliation from almost placebo doses of roentgen rays.

Since the report of Freund, there seems to have been no report until the communication of Pfahler.[73] He cited 4 cases in which patients were greatly benefited by small doses of roentgen rays delivered through about thirty fields, cross-firing chiefly on the spinal column, "but, of course, reaching all other parts of the body as well." More recently he has been using moderate doses of high voltage roentgen rays and he reported 5 cases in which life was prolonged for from one to four years. Such results are interesting in the light of the investigation of Meyerding, Carman and Garvin who, in 25 cases, determined that life expectancy is on the average four and seven-tenths months after the discovery of the metastasis. Jenkinson reported 3 cases in which patients were alive after three years, comparatively free from pain. He used high voltage roentgen rays, heavily filtered in moderate doses, and advised treatment in all such cases no matter how hopeless they may seem. Beck reported one case in which recalcification followed high voltage treatment of the pelvis. Belot and Lepennetier obtained indifferent results in the treatment of their patients. Giles had 7 cases, in 2 of which treatment was with high voltage. Pop reported 4 cases treated with 1.5 H.E.D. Palumbo treated 3 patients with 140 per cent H.E.D., according to the Seitz-Wintz technique, with indifferent results. Holmes mentioned one case in which the patient was improved by roentgen rays of high voltage. Joly had a patient in whom the roentgenogram gave evidence of recalcification of the seventh thoracic vertebra and freedom from pain seven months after treatment. Le Maitre obtained favorable results in one case. De Nabias reported one case of a patient successfully treated with radium. Jacobs treated a woman with extensive pelvic and vertebral involvement who

two years later was free of syptoms. Holfelder stated that he had a series of patients who were improved by high doses (110 to 120 per cent H.E.D.). Schlesinger, Lee and Herendeen, Pancoast, Grier, and Ginsburg have reported frequent improvement following treatment by roentgen rays. Borak[11] reported 15 cases in which treatment was with about 90 per cent H.E.D.; in only 2 was there no effect.

In the group of 40 cases reviewed here, 32 patients were treated for relief of pain; 8 were given placebo treatment, largely for its psychic effect. Of the 32 patients treated for relief of pain, in only 2 did the analgesia fail to appear. The period after treatment within which analgesia began was less than one day after treatment in 2 cases, two to three days after treatment in 12 cases, four days to a week after treatment in 8 cases, during the second week after treatment in 9 cases, and in one case there was slight relief one week after the first treatment but definite relief did not come until the second course. The data are inconclusive, but in 14 cases in which the relief of pain began from one to two weeks after treatment, the analgesia lasted two to four or more months, whereas in 17 cases the relief was more rapid, and lasted a shorter time, usually less than two months. There was no demonstrable relationship between the speed of onset of the relief from pain and its degree, and none between the time of onset of analgesia and its duration. In the 2 cases in which treatment failed, roentgenograms were positive for metastasis. I have no plausible explanation for the results in these cases.

The technique of treatment in this group brings out some very interesting, yet puzzling, clinical facts. From the standpoint of doses alone, both moderate* and high voltage produced analgesia. The time after treatment of onset of analgesia was not markedly different whether one or the other technique was employed. In fact, after almost any dose of roentgen rays over an involved region some relief of pain resulted. Nevertheless, almost uniformly, analgesia of greater duration was produced by high voltage than by moderate dosage. The degree of relief of pain was not constantly associated with the dose of roentgen rays administered, for, paradoxically, great relief resulted occasionally from low doses of roentgen rays. Analgesia began in many cases, treated with either technique, on the second to the fifth day after treatment. On closer investigation it appears that those patients treated with subintensive cross-fire of the pelvis with high voltage and the thoracolumbar part of the spinal column with moderate voltage seemed to get greater and longer relief than those in whom only the pelvis or diseased vertebra was treated through a single field. Cross-fire was more generally effective than treatment through a single field.

In considering results of treatment, there are two distinct phases to keep in mind: the symptomatic effect on the patient, and the organic changes in the lesion. That there is parallelism between them does not necessarily follow, as the reports of Desjardins and Ford, on the analgesic effects of roentgen rays, bring out. They, and others, have stated that analgesia results sometimes from destruction by roentgen rays of inflammatory or neoplastic processes, which impinge on nerves. However, in a considerable number of patients, such a mechanism does not come into play, and the assumption is that there is a direct effect of unknown nature on the nerve. There probably take place, therefore, three processes in relief of pain from osseous metastasis: destruction of inflammatory and of carcinoma cells, and direct action on the nerves.

To determine the effect of irradiation on a tumor, two factors are of fundamental importance: an effectively large dose must be absorbed by the lesion, and suf-

* "Moderate" voltage: 135 kv. (peak); 5 ma.; 40 cm. target-skin distance; 6 mm. aluminum filter; 30 to 35 min. exposure.

"High" voltage: 200 kv. (peak); 5 ma.; 50 cm. target-skin distance; 0.75 mm. copper plus 1 mm. aluminum filter; 60 to 80 min. exposure.

ficient time must elapse after irradiation for the effect to manifest itself. Clinically, response to treatment is shrinkage of the tumor sometime after the tenth day in most cases, although the time relationships of the recession are by no means constant. Whether tumor reactions can be predicted from a logarithmic curve, as can skin reactions, according to an idea of "saturation," is at present an unsettled question. Nevertheless, it is well known to therapists that regression of carcinoma taking place within a week after treatment is the great exception rather than the rule.

In some of these cases, the analgesia apparently came on too soon (one to five days), after too small doses of roentgen rays, for the effect to be mainly due to destruction of tumor and relief of pressure on nerve filaments. It must therefore be assumed either that carcinoma of the breast metastatic in bone has a sensitivity exceedingly greater than has the primary tumor as a rule, or that some other effect is the basis for the production of early analgesia.

In support of the first possibility is the work of Borak, Berven and others, who assigned an extremely high radiosensitivity to metastatic lesions in bone from carcinoma of the breast.

Earlier in this paper it was stated that a noninfectious inflammatory reaction has been observed by many authors as the accompaniment of carcinomatous deposits in bone. The frequency of this phenomenon is too great to be ignored. Although many have noted its presence, but have assigned to it a rôle of no clinical importance, it is, nevertheless, the destruction of this infiltrate which probably plays the major part in the early production of analgesia.

The great sensitivity of chronic inflammatory processes to moderate doses of roentgen rays has been established. The reports of Heidenhain and Fried, of Pordes, Bauer, Hodges, Liebersohn, and many others, have shown the rapid regression of inflammatory lesions in all situations following moderate doses of roentgen rays.

To settle the question as to whether it is mainly the resorption of products of inflammation after treatment by roentgen rays that causes the significant symptomatic change would necessitate microscopic study of a metastatic region before and after treatment. Such is not feasible clinically, but from the analogy of inflammations elsewhere it seems probable that a like destruction of a similar process in bone would have the same course and sequelae. The destruction of the inflammatory tissue probably explains the onset of analgesia within the first week after treatment.

In all cases in which treatment is given there takes place, coincidentally with the effect on the inflammation, an effect on the carcinoma. When the analgesic effect was slight, either there was little inflammation present, or the effective dose in the carcinoma was low. The malignant disease was merely slowed up, or the tissue only partly destroyed, and after a time the disease became active again. In those cases in which analgesia came on late (after more than a week), and was of long duration, the effect was probably on the carcinoma cells basically and on the inflammatory cells incidentally.

In some cases, almost complete analgesia of long duration followed treatment with high voltage. That such a technique is more effective than moderate voltage on deep-seated pelvic metastasis is a radiologic axiom. This leads to the supposition that radiation at high voltage produces more of an actual curative effect in the underlying malignant process, and that moderate voltage is effective in giving symptomatic relief by its action on concomitant inflammation. The course of events probably is destruction of the inflammatory lesions first (and early), which produces analgesia lasting until the second week, when the reaction on carcinoma begins to manifest itself, giving "permanency" to the clinical result.

It is not uncommon for a metastatic

lesion to repair itself after treatment. Such recalcification is a slow centripetal process, appearing several months after treatment, and running a protracted course as indicated by roentgenographic examination. New bone may so completely replace metastasis that the detection of the site of the old lesion is well nigh impossible. That such is not an exceptional thing is attested by the reports of Pfahler,[74] Joly, Borak,[12] Ginsburg,[32,33] and others, who often saw restitution of bony contour following treatment by roentgen rays.

Obviously, a report on curative effects of lesions such as those with which this paper is concerned is absurd. Nevertheless, the results obtained in more than 90 per cent of the cases dealt with in this paper in palliating for several months an apparently hopeless condition, which carries in its train excruciating and refractive pain, certainly make treatment by roentgen rays worth while. But sooner or later roentgen therapy loses its initial effectiveness. Usually one or two recurrences of symptoms due to reactivation of the metastasis in bone may be handled successfully, but sooner or later all treatment is useless.

SUMMARY

Metastasis from carcinoma of the breast reaches the pelvic and vertebral bones, probably by a combination of aberrant and reflux spreads through the lymphatics and is often accompanied by an inflammatory reaction of noninfectious origin. The most common symptom of such lesions is pain in the right sciatic nerve. The distribution and type of metastasis in the group studied bore no relationship to the primary tumor. Treatment by roentgen rays by an effect on both the inflammatory and malignant cells in the metastatic growths, produces analgesia, often complete and of months' duration, and is the best method of palliating a hopeless disease.

REFERENCES

1. Apolant, H. Ueber die Resorption und die Apposition von Knochengewebe bei der Entwickelung bösartiger Knochentumoren. *Arch. f. path. Anat.*, 1893, *131*, 40–77.
2. Aschoff, L. Pathologische Anatomie. Second edition. G. Fischer, Jena, 1911, 2 volumes.
3. Askanazy. *Festschr. für M. Jaffe 1902. Beitr. z. Knochenpath.*
4. Assmann, H. Zum Verständniss der Knochenbildung bei der osteoplastischen Karzinose. *Arch. f. path. Anat.*, 1907, *188*, 32; 111.
5. Assmann, Herbert. Die klinische Röntgendiagnostik. Second edition. F. C. W. Vogel, Leipzig, 1922, 740–745.
6. Axhausen, Georg. Histologische Studien über die Ursachen und den Ablauf des Knochenumbaus im osteoplastischen Karzinom. *Arch. f. path. Anat.*, 1909, *195*, 358–462.
7. Bauer, Friedrich. Röntgenbestrahlung von Entzündungen. *München. med. Wchnschr.*, 1925, *72*, 646–648.
8. Beck, E. G. Cancer therapy from the surgeon's standpoint. Am. J. Roentgenol. & Rad. Therapy, 1924, *11*, 117–137.
9. Belot, J., and Lepennetier, F. Métastases osseuses de cancers du sein. *J. de radiol. et d'électrol.*, 1925, *9*, 409–416.
10. Berven, Elis, Heyman, J., and Thoraeus, R. The technique in the treatment of tumours at Radiumhemmet, Stockholm. *Acta radiol.*, 1929, *10*, 1–71.
11. Borak, J. Röntgenbehandlung metastatischer Knochengeschwülste. *Arch. f. klin. Chir.*, 1926, *143*, 185–199.
12. Borak, J. Röntgenbehandlung von Knochenkarzinommetastasen. *Wien. klin. Wchnschr.*, 1926, *39*, 611.
13. Borak, J. Röntgenbehandlung metastatischer Knochengeschwülste. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, *Kongressheft*, *17*, 33–34.
14. Borak, J. Ueber die schmerzstillenden Wirkungen der Röntgenstrahlen. *Der Schmerz*, 1928, *2*, 90–105.
15. Buday, K. Statistik. *Ztschr. f. Krebsforsch.*, 1908, *6*, 1–63.
16. Carnett, J. B. Scirrhous carcinoma of the breast with extensive metastases. *Surg. Clin. N. Am.*, 1927, *7*, 7–30.
17. Carter, L. J. Spinal metastasis from breast carcinoma. *Canad. M. Ass. J.*, 1926, *16*, 48–51.
18. Courvoisier. Dan Prostatacarcinom, dissertation. M. Werner-Riehm, Bazel, 1901, 130 pp.
19. Deaver, J. B., and McFarland, Joseph. The Breast, Its Anomalies, Its Diseases and

Their Treatment. P. Blakiston's Son & Co., Philadelphia, 1917, 724 pp.

20. De Nabias, S. Traitement des métastases osseuse par la curiethérapie. *Bull. de l'Ass. franç. p. l'étude du cancer*, 1926, *15*, 68–73.

21. Desjardins, A. U. The analgesic property of roentgen rays. *Radiology*, 1927, *8*, 317–324.

22. Erbslöh, Walter. Fünf Fälle von osteoplastischem Carcinom. *Arch. f. path. Anat.*, 1901, *163*, 20–44.

23. Ewing, J. Neoplastic Diseases. Second edition. W. B. Saunders Co., Philadelphia, 1922, 1054 pp.

24. Fischer-Defoy, W. Vier Fälle von osteoplastischem Prostatacarcinom. *Ztschr. f. Krebsforsch.*, 1905, *3*, 195–217.

25. Flatau, Edward. Wirbel- und Rückenmarksgeschwülste. In: Handbuch der Neurologie. Zweiter Band specielle neurologie. I. Julius Springer, Berlin, 1911, 616–684.

26. Ford, Frances A. Roentgenotherapy in certain types of neuritis and neuralgia. *Minn. Med.*, 1928, *11*, 368–374.

27. Fraenkel, E. Ueber Wirbelgeschwülste im Röntgenbilde. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1910–1911, *16*, 245–257.

28. Freund, Leopold. Röntgenbehandlung der Ischias. *Wien. klin. Wchnschr.*, 1907, *20*, 1611–1612.

29. Fitzwilliams, D. C. L. On the Breast. C. V. Mosby Co., St. Louis, 1924, p. 408.

30. George, A. W., and Leonard, R. D. The vertebrae. Annals of Roentgenology, 1929, *8*, 46.

31. Giles, R. G. Skeletal metastasis from primary carcinoma of the breast. Am. J. Roentgenol. & Rad. Therapy, 1925, *14*, 442–448.

32. Ginsburg, S. Osteoplastic skeletal metastases from carcinoma of the breast; report of unusual case. *Arch. Surg.*, 1925, *11*, 219–236.

33. Ginsburg, S. Pain in cancer of the breast; its clinical significance with special reference to bone metastases. *Am. J. M. Sc.*, 1926, *171*, 520–535.

34. Goetsch. W. Über der Einfluss von Karcinommetastasen auf das Knochengewebe. *Beitr. z. path. Anat. u. z. allg. Path.*, 1906, *39*, 218–251.

35. Goforth, J. L. A consideration of body resistance to neoplasia. *Am. J. M. Sc.*, 1928, *175*, 504–510.

36. Handley, W. S. Cancer of the Breast and its Treatment. Second edition. Paul B. Hoeber, New York, 1922, 411 pp.

37. Heidenhain, L., and Fried, C. Röntgenstrahlen und Entzündung. *Klin. Wchnschr.*, 1924, *3*, 1121–1122.

38. Helly, Konrad. Metastatische Tumoren. In: Henke, F., and Lubarsch, O. Handbuch der speziellen pathologischen Anatomie und Histologie. Julius Springer, Berlin, 1927, i, 1072–1099.

39. Hodges, F. M. The roentgen ray in treatment of carbuncles and other infections. Am. J. Roentgenol. & Rad. Therapy, 1924, *11*, 442–445.

40. Holfelder, H. In Krause, Paul: Handbuch der Röntgentherapie. G. Thieme, Leipzig, 1928, p. 522.

41. Holmes, G. W. Discussion on a case of recurrent carcinoma of the breast treated with x-rays. *Boston M. & S. J.*, 1927, *197*, 1001–1003.

42. Ingraham, Ruth. Carcinomatous metastasis to bone. *Surg. Clin. N. Am.*, 1927, *7*, 877–894.

43. Jacobs, A. W. Skeletal and pulmonary metastases from carcinoma of the breast; treatment by radiation. *Med. J. & Rec.*, 1927, *125*, 237–239.

44. Jenkinson, E. L. The roentgen treatment of breast carcinomata. *Radiology*, 1924, *2*, 151–155.

45. Joll, C. A. Metastatic tumours of bone. *Brit. J. Surg.*, 1923, *11*, 38–72.

46. Joly, M. Radiodiagnostic et radiothérapie d'un cancer secondaire de la colonne dorsale. *Bull. et mém. Soc. de radiol. méd. de France*, 1926, *14*, 198.

47. Jüngling, O. Röntgenbehandlung chirurgischer Krankheiten zugleich Einführung in die physikalischen und biologischen Grundlagen der Röntgentherapie. S. Hirzel, Leipzig, 1924, 468 pp.

48. Kaestle, K. In: Rieder, Hermann, and Rosenthals, Josef. Lehrbuch der Röntgenkunde. J. A. Barth, Leipzig, 1922, p. 292.

49. Kaufmann, E. Quoted by Ginsburg.

50. Kaufmann, Edward. Lehrbuch der pathologischen Anatomie. P. Blakiston's Son & Co., Philadelphia, 1929, ii, 1222.

51. Kelly, H. A., and Fricke, R. E. Problems in treatment of carcinoma of the breast. *Surg., Gynec. & Obst.*, 1924, *38*, 399–402.

52. Kienböck, R. On the tumourous diseases of the bones, primary and metastatic. *Brit. J. Radiol.*, 1926, *31*, 374–385.

53. Kitain, H. Zur Kenntnis der Haufigkeit und der Lokalisation von Krebsmetastasen mit besonderer Berüchsichtigung ihres histologischen Baues. *Arch. f. path. Anat.*, 1922, *238*, 289–309.

54. Klein. In: Gray, Henry. Anatomy of the Human Body. Twenty-first edition. Lea and Febiger, Philadelphia, 1924, p. 87.

55. Kolodny, Anatole. The relation of the bone marrow to the lymphatic system; its role in spreading of carcinomatous metastases throughout the skeleton. *Arch. Surg.*, 1925, *11*, 690–707.

56. LANZINGER. Quoted by Ginsburg.
57. LEE, B. J., and HERENDEEN, R. E. The treatment of primary inoperable carcinoma of the breast by radiation. *Radiology*, 1924, *2*, 121–136.
58. LEE, B. J., and TANNENBAUM, N. E. Recurrent inoperable carcinoma of breast; analysis of 363 cases treated by radium and roentgen ray. *J. Am. M. Ass.*, 1926, *86*, 250–256.
59. LEMAITRE, L. Résultats favorables, etc. *Presse méd.*, 1926, *1*, 41.
60. LEVIN, I. The prognostic and therapeutic significance of skeletal metastases in carcinoma of the breast. *Ann. Surg.*, 1917, *65*, 326.
61. LIEBERSOHN, J. Zur Behandlung entzündlicher Erkrankungen mit Röntgenstrahlen in kleinen Dosen. *Strahlentherapie*, 1929, *32*, 356–360.
62. MANDL, FELIX. Zur Behandlung der durch Karzinommetastasen hervorgerufenen Ischialgien. *Wien. klin. Wchnschr.*, 1927, *40*, 942–944.
63. MATTHEWS, A. A. Secondary carcinoma of the bone. *N. York M. J.*, 1915, *101*, 1150–1157.
64. MEYERDING, H. W., CARMAN, R. D., and GARVIN, J. D. Metastasis to the bones from carcinoma of the breast; roentgenologic study. *Radiology*, 1925, *5*, 486–489.
65. MOORE, A. B. A roentgenologic study of metastatic malignancy of the bones. AM. J. ROENTGENOL., 1919, *6*, 589–593.
66. MUELLER, BERTHOLD. Ein Beitrag zur Knochencarcinose. *Arch. f. path. Anat.*, 1924, *249*, 305–314.
67. OPPENHEIMER, E. D. Early symptoms of spinal cancer. *J. Bone & Joint Surg.*, 1922, *4*, 342–356.
68. PALUMBO, V. Metastasi ossee del Bacino da carcinoma mammario operato. *Riforma med.*, 1926, *42*, 515–516.
69. PANCOAST. Discussion.
70. PATEY, D. H. Some notes on the clinical features and the distribution of secondary deposits in bone following carcinoma of the breast. *Brit. J. Surg.*, 1927–1928, *15*, 182–192.
71. PEET, M. M. The control of intractable pain in the lumbar region, pelvis, and lower extremities by section of anterolateral columns of spinal cord (chordotomy). *Arch. Surg.*, 1926, *13*, 153–204.
72. PFAHLER, G. E. The roentgen diagnosis of metastatic malignant disease of bone. AM. J. ROENTGENOL., 1917, *4*, 114–122.
73. PFAHLER, G. E. The treatment of metastatic carcinoma of the spine by deep roentgen therapy. *Surg., Gynec. & Obst.*, 1919, *29*, 236–241.
74. PFAHLER, G. E. The roentgen treatment of metastatic carcinoma of the bone. *Acta radiol.*, 1926, *7*, 280–288.
75. PFÖRRINGER. Kasuistischer Beitrag zur Röntgendiagnostik der Wirbeltumoren. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1910, *15*, 34–37.
76. PINEY, A. The anatomy of the bone marrow. *Brit. M. J.*, 1922, *2*, 792–795.
77. POP, L. Über osteoklastische und über osteoplastische Karzinome und deren Beeinflussbarkeit durch die Röntgentherapie. *Cluj. med.*, 1926, *7*, 476.
78. PORDES, F. Die Röntgentherapie entzündlicher Affektionen insbesondere im Beriche der Kiefer. *Ztschr. f. Stomatol.*, 1925, *23*, 252–263.
79. RAHM, HANS. Die Röntgentherapie des Chirurgen. F. Enke, Stuttgart, 1927, 547 pp.
80. VON RECKLINGHAUSEN, F. Die Fibröse oder deformirende Ostitis, die Osteomalacie und die osteoplastische Carcinose in ihren gegenslitigen Beziehungen. *Festschr. R. Virchow*, 1891, 1–89.
81. RISLEY, E. H. Skeletal cancer. *Boston M. & S. J.*, 1915, *172*, 584–587.
82. RITCHIE, J., and STEWART, J. P. General secondary carcinoma of the bones, osteomalacia carcinomatosa. *Edinburgh M. J.*, 1896–1897, *43*, 208–220.
83. ROGER and JOSUÉ. Quoted by Kolodny.
84. SCHINZ, H. R., BAENSCH, W., and FRIEDL, E. Lehrbuch der Röntgendiagnostik. G. Thieme, Leipzig, 1928, pp. 199–207.
85 SCHLESINGER, HERMANN. Die Diagnose und Therapie der karzinomatösen Wirbelmetastasen. *Wien. klin. Wchnschr.*, 1928, *41*, 205–206.
86. SCHMORL, G. Ueber Krebsmetastasen im Knochensystem. *Verhandl. d. deutsch. path. Gesellsch.*, 1908, *12*, 89–94.
87. SICARD, J. A., BELOT, J., COSTE, and GASTAUD. Aspects radiographiques du cancer vertébral. *J. de radiol. et d'électrol.*, 1925, *9*, 353–382.
88. SICARD, J., LERMOYEZ, J., and LAPLANE, L. Les signes radiologiques du cancer vertébral. *Ann. de méd.*, 1923, *13*, 383–389.
89. SIMONSON, S. Die schmerzstillende Wirkung der Röntgen- und Radiumstrahlen. *Strahlentherapie*, 1913, *2*, 192–223.
90. SIMPSON, B. T. Pathology of breast cancer with special reference to metastasis. AM. J. ROENTGENOL. & RAD. THERAPY, 1926, *16*, 431–439.
91. SNOW, HERBERT. The insidious marrow lesions of mammary carcinoma. *Brit. M. J.*, 1892, *1*, 548–551.
92. WOLFF, RICHARD. Zur Kenntniss der metastatischen Erscheinungen des Prostatacarcinome. *Deutsche Ztschr. f. Chir.*, 1899, *52*, 397–411.
93. WOLFF, JULIUS. Zur Osteoplastik. *Berl. klin. Wchnschr.*, 1869, *6*, 492–494.

VOL. XXIV, No. 6

DEEP ROENTGEN-RAY THERAPY OF MAMMARY CARCINOMA*

II. FIVE YEAR RESULTS

VALUE OF THE METHOD AS AN AUXILIARY TO SURGICAL PROCEDURES IN THE OPERABLE, AND AS A PRIMARY PROCEDURE IN THE INOPERABLE CASES

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AT THE Sixth Annual Meeting of the Central Section of the American Roentgen Ray Society, held in February, 1925, in Detroit, we presented our first experiences with deep roentgen therapy in carcinoma of the breast[1]. At that time we also gave in detail our method of procedure and the technique of irradiation in both the operable and inoperable cases and arrived at the conclusion that roentgen therapy in its new, short wave length application, forms one of the most powerful agents in the treatment of mammary carcinoma. The series included 173 cases treated between 1922 and 1924.

In this present article we wish to give a detailed statistical account of the "five year results" obtained in the above series.

CLASSIFICATION

In the first publication the following classification of mammary carcinoma was followed:

A. Primary carcinoma, treated by combined surgery and radiation.

B. Primary carcinoma, treated by radiation alone.

C. Recurrent carcinoma following surgery, treated by radiation alone.

According to the extension of the lesion at the time of the treatment the carcinoma was divided into five clinical groups.

I. Small, single, freely movable carcinoma focus.

TABLE I

Class	A					B					C					
Group	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	yearly total
1922	4	19	2	2	0	1	1	2	0	0	0	0	10	11	9	61
1923	4	11	1	3	0	0	1	3	1	2	0	2	7	8	7	50
1924	9	18	3	5	0	0	0	0	1	6	0	2	7	6	7	64
Total	65		16			3		15			4		72			

Total cases treated.....175

II. Large, single or multiple carcinoma with involvement of the axillary lymph nodes.

III. Extension of the carcinoma to the supra-, infraclavicular and cervical lymph nodes.

IV. Thoracic (pleural, lung, mediastinal, or thoracic cage) extension.

V. Abdominal and general carcinomatous metastases.

The distribution of the cases according to the method of treatment and stage of the disease is shown in Table I.

In comparing the above table with that published in 1925, the only change is the

[1] Evans, W. A., and Leucutia, T. Deep roentgen-ray therapy of mammary carcinoma. AM. J. ROENTGENOL. & RAD. THERAPY, 1925, *14*, 135–148.

* Read at the Thirtieth Annual Meeting, American Roentgen Ray Society, New York City, Sept. 17–20, 1929.

addition of two new cases, which at that time could not be classified with certainty but which later definitely proved to be carcinomatous recurrences (both belonging to C III), so that the total number of cases now reaches 175.

All cases, with the exception of 9 (5 per cent), were followed up. Six of the 9 untraceable cases belong to Groups A I and A II which makes us believe that some of these patients must still be alive. This viewpoint is strengthened also by the fact that only recently two other cases which belong to the same group and which were thought to be lost have appeared for examination and were found to be entirely free of the disease.

In figuring the percentages of the five year results in the present study, all patients who could not be located were included among the dead. It was also assumed that all patients dead have succumbed from cancer, although in several instances there was no evidence of carcinoma of any kind at the time of death. Thus, the statistics shown below represent the most unfavorable figures under the circumstances.

In the 65 cases of Groups A I and II, the operation was either radical or semiradical, and was followed by from one to three series of deep roentgen therapy. In the 6 cases of Group A III, the operation consisted in the removal of the breast and axillary tissues, the enlarged supra-, infraclavicular and cervical lymph nodes being left intact. In the 10 cases of Group IV, the operation was purely palliative, being confined to the local removal of the tumor. In all these instances, as well as those of Groups B and C, extensive irradiation constituted the chief method of treatment.

STATISTICAL RESULTS

The three and five year results are as follows.

A. In the cases operated upon and then irradiated.

I. In carcinomas without involvement of the axillary lymph nodes, 17 cases (Table II).

TABLE II

A I	Cases	Untraced	Results	
			3 years	5 years
1922	4		4	4
1923	4	1	2	2
1924	9	1	7	6
Total	17	2	13	12

II. In carcinomas with involvement of the axillary lymph nodes, 48 cases. Here 3 cases were eliminated; one, since death occurred from pneumonia one week following the operation, and 2 cases, since not even the first series of irradiation could be completed (Table III).

TABLE III

A II	Cases	Untraced	Results	
			3 years	5 years
1922	18	2	13	11
1923	11		8	4
1924	16	2	7	6
Total	45	4	28	21

The above results were analyzed also with regard to age incidence (Table IV)

TABLE IV

Age	Cases	Untraced	Results	
			3 years	5 years
20–30	3		3	3
30–40	12	1	8	6
40–50	27	3	16	12
50–60	8	1	5	3
60–70	11	1	8	8
70–80	1		1	1
Total	62	6	41	33

and the type of operation performed (Table V).

Table V

A I	Cases	Results	
		3 years	5 years
Radical operation	9	7	7
Semiradical operation	8	6	5
Total.....	17	13	12

A II	Cases	Results	
		3 years	5 years
Radical operation	26	18	14
Semiradical operation	19	10	7
Total.....	45	28	21

III. In carcinomas with involvement of the supra-, infraclavicular and cervical lymph nodes, 6 cases (Table VI).

Table VI

A III	Cases	Results	
		3 years	5 years
1922	2	1	1
1923	1		
1924	3	2	1
Total	6	3	2

IV–V. In carcinomas with generalized metastases, 10 cases (Table VII).

Table VII

A IV–V	Cases	Results	
		3 years	5 years
1922	2		
1923	3		
1924	5	1	1
Total	10	1	1

B. In the cases treated by radiation alone, in all stages, 18 cases (Table VIII).

C. In cases of recurrence following operation and later treated by radiation.

Table VIII

B	Cases	Untraced	Results	
			3 years	5 years
I	1		1	1
II	2		2	2
III	5	1	2	1
IV–V	10			
Total	18	1	5	4

I–II. In carcinomas, localized or involving the axillary lymph nodes, 4 cases (Table IX).

Table IX

C I–II	Cases	Untraced	Results	
			3 years	5 years
	4	1	1	1

III. In carcinomas with involvement of the supra-, infraclavicular and cervical lymph nodes, 24 cases (Table X).

Table X

C III	Cases	Untraced	Results	
			3 years	5 years
1922	10		3	3
1923	7	1	2	1
1924	7		4	4
Total	24		9	8

IV–V. In carcinomas with distant metastases, 48 cases (Table XI).

Table XI

C IV–V	Cases	Untraced	Results	
			3 years	5 years
1922	20		2	1
1923	15	1	3	1
1924	13		1	
Total	48	1	6	2

DISCUSSION

A. Of the cases treated by surgery and radiation 76.47 per cent (13 out of 17) have remained well for three years and 70.59 per cent (12 out of 17) for five years, if the carcinoma did not spread to the adjacent lymph nodes, and 62.22 per cent (28 out of 45) and 46.66 per cent (21 out of 45) reached the three- and five-year period respectively, if the carcinoma involved the axillary lymph nodes. If the operation was radical, that is, if all of the breast the axillary tissues, including both pectoral muscles, were removed, the three- and five-year results remained the same, viz., 77.77 per cent (7 out of 9) in the cases without glandular involvement and they were 69.23 per cent (18 out of 28) and 53.84 per cent (14 out of 18) respectively, in the cases with involvement of the axillary lymph nodes. If the operation was semiradical, that is, either the pectoral muscles were not removed or the whole axilla was left intact, the results were 75 per cent (6 out of 8) and 62.50 per cent (5 out of 8) respectively, in the cases without glandular involvement, and 52.63 per cent (10 out of 19) and 36.39 per cent (7 out of 19) respectively, in the cases with involvement of the axillary lymph nodes. The age incidence remained without influence on the final results.

If one compares the above figures with those of the available surgical statistics, where no postoperative irradiation was used, two things immediately strike the observer: first, there is no noticeable improvement from the addition of the radiation in the cases of carcinomas without glandular involvement above those obtained by surgery alone; second, in the cases where the carcinoma has already spread to the axillary lymph nodes, the results, through addition of radiation, were more than doubled. An explanation of these phenomena is easily obtained if one considers the purpose of the irradiation and the benefits resulting therefrom. On the basis of the present day technique employed in the postoperative irradiation of breast carcinomas, it is quite logical to assume that there should be no marked difference in the results obtained with or without roentgen treatment in the cases without glandular involvement. Since a radical operation has, or at least is supposed to have, removed all the tissues diseased, roentgen therapy could accomplish no more. Not so, however, in the cases with extension of the carcinoma to the axilla, and as we shall see, also to the supra-, infraclavicular and cervical lymph nodes. Here a thorough irradiation of the entire anterior thorax, axilla and neck often covers eventual foci of carcinoma, which could not be foretold, and still less removed, at the time of the operation, no matter how extensive and radical the operation might have been. That this is so follows also from our statistical study of the results of the postoperative irradiation in different types of operation (Table v). If only a semiradical operation is performed but the patient irradiated, the final resluts are more favorable than when the operation is radical and no postoperative irradiation is used. It is essential, though, that in such instances the irradiation be carried out systematically and over a period of longer duration (for at least three series at six to eight weeks' intervals), in order to obtain the desired effect. The reason why, in our cases, the results of the irradiation in the semiradical operations do not reach the same high standard as in the radical operations, is to be sought, at least partly, in the failure of several of the patients to return for a repetition of the treatment as advised. For the same reason, we believe that the best method of treatment is radical operation, followed by a thorough course of irradiation. In our first publication we expressed the opinion that if the operation is radical, one series of irradiation is sufficient to entirely eradicate the remaining carcinomatous foci, and that a repetition of the treatment is not necessary. Now we believe that it is wiser, and certainly safer, to repeat the treatment (with gradually attenuated doses) for at least

3 to 4 series, at from six to eight weeks' intervals, in all instances.

Of the cases with involvement of the supra-, infraclavicular and cervical lymph nodes, and in which the most radical operation must necessarily remain incomplete, 50 per cent (3 out of 6) reached the three-year, and 33.33 per cent (2 out of 6) reached the five-year period. Of the 10 cases with distant metastases, only one reached the three- and five-year periods. The average life duration of the case which died will be discussed later.

B. We do not believe that a carcinoma of the breast should be primarily treated by irradiation—unless there are definite contraindications to operative procedure—therefore we shall not attempt to discuss this phase of the work. Table VIII, showing the results in the breast carcinomas of all stages primarily treated by radiation, is included merely as a matter of record.

C. Of the cases which did not receive roentgen therapy following the operation, and which later recurred, only 4 belonged to Group II. This number is too small to permit adequate conclusions.

Of the 24 cases which belonged to Group III, 37.50 per cent (9 out of 24) were well at the end of three years, and 33.33 per cent (8 out of 24) were well at the end of five years. These figures coincide with those of Group A III, and must be considered therefore as the average result of all carcinomas of the breast already having involved the highest glands.

Of the 51 cases with distant metastases, only 11.76 per cent (6 out of 51) reached the three-year period, and 3.92 per cent (2 out of 51) reached the five-year period.

We also estimated the average life duration in the cases belonging to Groups III and IV–V who died, and found the following figures (Table XII).

It appears thus that in Group III, that is, in the cases with involvement of the high glands—even by discounting the patients still alive (20–33 per cent)—a definite prolongation of life is obtained in all instances by the addition of roentgen therapy. The exceedingly high values for the total life duration in Group C are due to the fact that 4 cases are included in which the recurrence occurred five, seven, ten, and twelve years respectively, after the operation.

In Groups IV–V, that is, in the cases with generalization of the carcinoma, the average life duration, as a whole, remains uninfluenced, and alleviation of the symptoms is all that can be expected from the irradiation.

TABLE XII

III	Cases	Average life duration after roentgen treatment	Average life duration since onset of disease
A	4	1 yr. 7 mos.	3 yrs. 4 mos.
B	3	2 yrs.	3 yrs. 9 mos.
C	24	1 yr. 6 mos.	4 yrs. 6 mos.

TABLE XIII

IV–V	Cases	Average life duration after roentgen treatment	Average life duration since onset of disease
A	9	1 yr. 1 mo.	2 yrs. 5 mos.
B	10	8 mos.	2 yrs. 11 mos.
C	48	11 mos.	3 yrs. 1 mo.

SUMMARY

Roentgen therapy, in its short wave length application, is of considerable aid in

treatment of operable mammary carcinoma as an auxiliary to surgical procedures.

Whereas, in the cases without glandular involvement, the addition of irradiation does not seem to noticeably increase the five-year results above those of surgery alone, assuming, of course, that all the diseased tissues were removed, in the carcinomas which had already spread to the axillary or the high thoracic lymph nodes, the five-year results are nearly doubled.

The best method of procedure is a combination of radical surgery with a thorough systematic irradiation of the entire anterior thorax, axilla and neck on the diseased side.

In the inoperable or recurrent mammary carcinomas, roentgen therapy produces prolongation of life if the lesion is localized to the adjacent lymph nodes or anterior thorax and alleviates the symptoms if the carcinoma is already generalized.

Vol. XXIV, No. 6

TRAUMATIC RUPTURE OF THE DIAPHRAGM

CASE REPORT

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CASES of traumatic rupture of the diaphragm are relatively infrequent. This case extended over such a long period of time, undetected, and the end-results were so satisfactory that it seemed worth while reporting.

Patient was a male, aged thirty, weight 188 pounds; occupation, general trucking business.

In March, 1924, he was severely injured in an automibile accident, and among other injuries, received four fractured ribs in the left hemithorax posteriorly. Roentgen examination at that time (Fig. 1) apparently showed a hydropneumothorax, and a plate taken a week later (Fig. 2) showed a well-defined area of collapsed lung and an apparent increased height of fluid level. Aspiration of the chest, however, at this time, brought no fluid. The heart was somewhat displaced to the right.

In 1926, two years later, re-examination of the chest (Fig. 3) showed an apparent re-expansion of this lung as evidenced by the disappearance of the collapsed area seen in Figure 2. At this time, the patient complained of slight dyspnea on exertion. He felt unable to work, was tired all the time, and had considerable insomnia, but no digestive disturbance.

FIG. 1. Simulating a hydropneumothorax.

FIG. 2. Area of collapsed lung and apparent increase in amount of fluid.

In June, 1927, because of continuance of dyspnea and general malaise, he consulted a prominent internist, who, upon examination of his chest, reported a pleural thickening from the old injury, but no other abnormal findings.

In May, 1929, the patient experienced his first digestive disturbances. It will be noted that this was over five years from the time of the accident. At this time, he complained of considerable epigastric pain following meals. The pain was very severe at times. This was frequently followed by vomiting and eructations of large quantities of gas, after which he experienced considerable relief. Appetite was good, but he was afraid to eat much because of distress following. He observed that he rested better if in the upright position, and frequently spent the entire night sitting upright in a chair. His bowels were quite regular, but he had lost 35 pounds in weight. Roentgen examination of his chest at this time (Fig. 4) showed

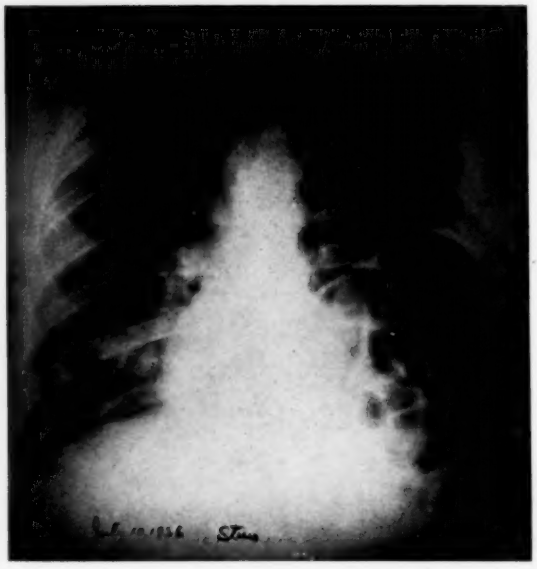

FIG. 3. Apparent re-expansion of lung.

large accumulations of gas in the left hemithorax through which the lung structure could not be discerned. This was bounded above by a dense fibrous band arising from the esophageal opening of the stomach, and extending up to the first interspace in the nipple line, where it was apparently lost. Roentgenoscopic examination showed an upward excursion of this entire structure, synchronous with the right diaphragm, but more limited in its excursion. The identity of these fibrous bands was considerably in doubt. It simulated somewhat a pneumothorax, but there did not appear to be evidence of much collapsed lung above this band. A lateral plate (Fig. 5) apparently showed an anterior leaf of diaphragm extending upward and backward but not completed in the posterior leaf. A prominent roentgenologist seen in consultation thought that this condition was probably a congenital absence of this left diaphragm, and that the band represented thickened upper border of the stomach.

Because of the onset of the digestive dis-

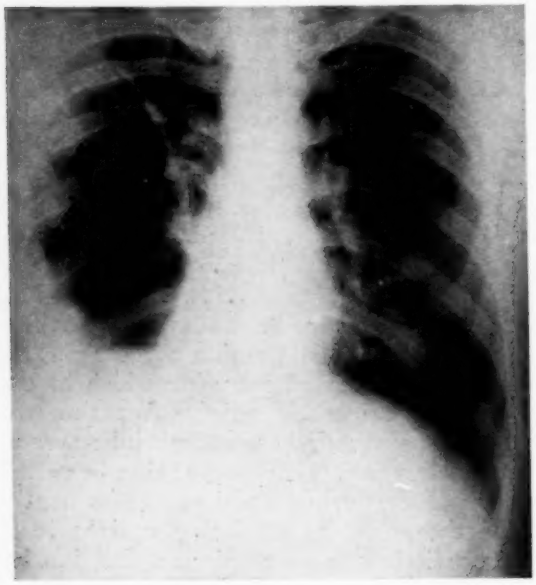

FIG. 4. Simulating pneumothorax, five years later.

FIG. 5. Simulating anterior leaf of diaphragm, or upper thickened border of stomach wall.

turbances, a gastrointestinal examination was made. This showed (Fig. 6) the barium flowing from the lower end of the esophagus into the stomach, which ascended into the thoracic cavity to the second interspace, definitely outlining the stomach. The dense band previously described as arising from the esophageal opening did not appear at this time (Fig. 7) and was probably obscured by overlying barium in the stomach. The barium was observed, roentgenoscopically, to empty rapidly from the stomach when the patient was in the upright position, but slowed down considerably with the patient supine, thus affording a ready explanation of his greater comfort sitting upright. A twenty-

four hour plate (Fig. 8) showed the splenic flexure rising in the thoracic cavity. There is no portion of the diaphragm, as such, which could be definitely identified and it was because of this that there was thought to be a congenital absence of the diaphragm.

In late September, 1929, this patient went to the Mayo Clinic, where he was operated on by Dr. Harrington. The report of the operation is as follows:

"Examination showed a left traumatic hernia of the diaphragm which was movable and synchronous with the right diaphragm. On Sept. 29, a left phrenicotomy was performed

Fig. 6. Barium passing through lower end of esophagus into a thoracic stomach.

and the nerve re-sutured with silk. On Oct. 2, an abdominal closure of the diaphragm was made. The entire stomach, all the transverse colon and greater omentum, a portion of the splenic flexure, several loops of small bowel and the spleen were found in the left thoracic cavity, herniated through a large opening in the diaphragm which extended from the chest wall laterally to a point one-half inch from the esophageal opening. Many adhesions were found between the stomach and the lungs as well as between the diaphragm and lateral chest wall.

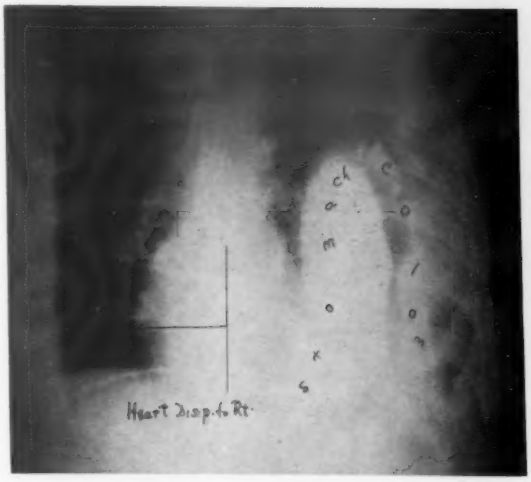

Fig. 7. Stomach and colon in thoracic cavity.

The lung was completely collapsed. The opening in the diaphragm measured 20 cm., which was closed by plastic over-lapping. The stomach was enormously dilated and thick walled as was also the transverse colon."

The patient made a rather stormy convalescence, but returned home in January in robust health, after spending fourteen weeks in the hospital. He is now free from his attacks of pain, eats his meals regularly and has gained 50 pounds in weight.

Reviewing these plates in the light of the operative findings then, we find that

Fig. 8. Splenic flexure in thoracic cavity.

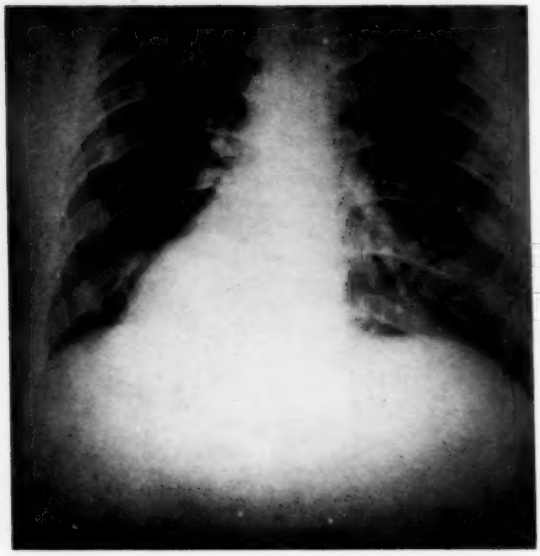

FIG. 9. Complete re-expansion of left lung following operation.

the ruptured leaves of the diaphragm were merged with the thickened walls of the stomach and the lateral chest wall by adhesions to so great an extent that they had lost their identity as such, thereby giving rise to the mistaken diagnosis of congenital absence of the diaphragm.

There was an initial pneumothorax, with lung collapsed up to the inner third of the second interspace. This lung did partially re-expand, as seen on the plate taken one year later, but according to the surgical report of the operation, it was again found completely collapsed.

An interesting feature in this case is the freedom from gastric disturbances over a period of five years following the accident, though there was a progressive decline in health during this period, during all of which time, the stomach and a considerable portion of the bowels were in the thoracic

FIG. 10. Posterior leaf of right diaphragm.

FIG. 11. Posterior leaf of left diaphragm seen above that of the right.

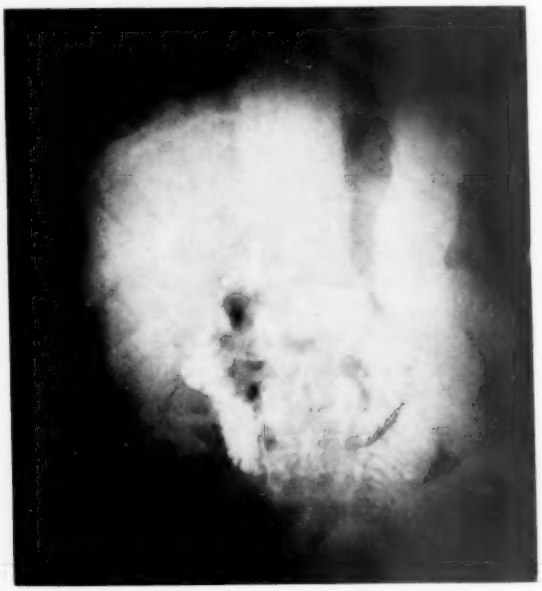

FIG. 12. Stomach and small intestine in normal position.

cavity. This absence of gastric symptoms was largely responsible for our having overlooked the true situation for so long a period. Even after discovering this fact, the condition was still obscured because of the loss of identity due to the diaphragm having become merged with the walls of the stomach and lateral chest. The complete re-expansion of the lung (Fig. 9) after a collapse extending over five years during which dense adhesions had formed is of interest. This also shows a completely repaired diaphragm. It is difficult to imagine that there had ever been a rent of eight and one-half inches in this diaphragm, so perfect is the repair. The only clue is the somewhat inhibited excursion involving the posterior leaf as seen by comparing Figures 10 and 11, lateral plates, Figure 10 showing the appearance on moderate inspiration and Figure 11 on deep inspiration.

Gastrointestinal examination upon his return (Figs. 12 and 13) shows the entire abdominal contents, stomach, bowel, and so forth, restored to their normal position.

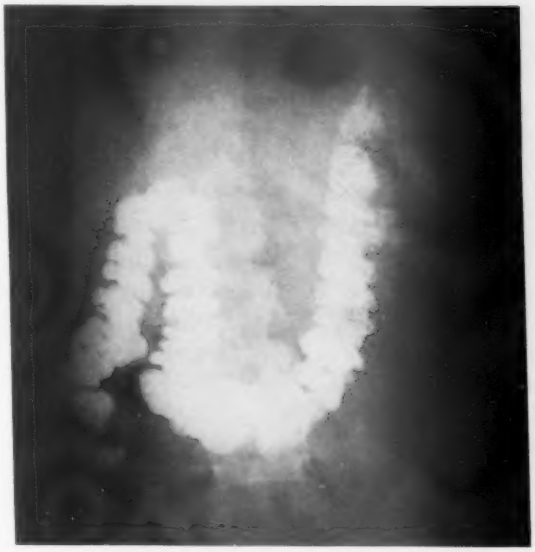

Fig. 13. Colon restored to normal position.

DIVERTICULUM OF THE DUODENUM PERFORATED INTO THE PANCREAS

REPORT OF CASE

By JOSEPH H. LUCINIAN, M.D.

From the Department of Roentgenology, Victoria Hospital

MIAMI, FLORIDA

PERFORATION of a duodenal diverticulum into the pancreas in which the diagnosis was made by roentgen examination is thought to be of sufficient rarity and interest to warrant reporting the following case:

A. C. J., a married, white woman, aged thirty-six, was referred, Dec. 31, 1927, from the surgical service of Dr. John A. Simmons, for roentgen examination of the gall-bladder. The clinical diagnosis was cholecystitis. Her chief complaint was pain in the epigastrium of eight years' duration. The family and past history was negative. The present history dated back eight years at which time she began to have attacks of sharp pain in the epigastrium, at first long intervals apart, but gradually becoming more frequent. At no time did the pain radiate to the right shoulder or the spine. There was no history of vomiting, hematemesis or blood in the stools. No relationship could be elicited between the attacks and the taking of food. Sodium bicarbonate gave inconstant relief. There were periods of varying length in which she was entirely free from pain. At times the attacks would come on at night to wake her from sleep.

Roentgen examination by the Graham test showed evidence of chronic cholecystitis associated with cholelithiasis. Examination of the stomach was not requested. Cholecystectomy was done and about sixty small gallstones were recovered. The patient was discharged as cured.

Two years later, Dec. 7, 1929, the same patient was referred by Dr. S. E. Chambers for roentgen examination of the gastrointestinal tract. Her chief complaint at this time was indigestion and pain in the epigastrium. She was relieved from pain and distress for a short period after the operation but these returned, identical in intensity and character. There was no history of hematemesis or relief from taking of food. The clinical diagnosis was duodenal ulcer.

Roentgenoscopic examination showed no delay, spasm, relaxation or regurgitation in the esophagus. There was no evidence of organic lesion in the stomach. The pylorus and the duodenal bulb showed no deformity and were not tender. On deep palpation there was an area of exquisite tenderness bounded by the loops of the first, second and third portions of the duodenum. The patient felt faint. An attempt was made to force the contrast meal in the horizontal loop of the duodenum back towards the bulb when a large globule of barium "shot" out from the lumen of the duodenum and filled an ovoid sac, about 1 cm. in diameter. The sac was connected with the lumen of the duodenum by a short, narrow neck. Its dependent portion was not round as seen normally in diverticula elsewhere but pointed down and appeared to dip into the head of the pancreas. The area of exquisite tenderness corresponded exactly to this area. At the end of five hours the stomach and small intestines were completely empty but the sac was still filled with barium. The roentgen diagnosis was duodenal diverticulum perforated into the head of the pancreas. This was confirmed by the surgeon who found the neck of the diverticulum opening into the duodenum just proximal and posterior to the entrance of the common bile duct. It had perforated into the head of the pancreas and was walled off by inflammatory tissue. The sac was resected, the stump inverted and closed with purse string sutures. The patient made an uneventful recovery. A month later a roentgenoscopic examination showed total absence of the sac and its neck. There was no seepage of barium from the lumen of the duodenum. The patient was entirely free from all symptoms.

DISCUSSION

Diverticula of the duodenum are usually primary or congenital. As a rule they occur singly. Rarely they give rise to symptoms or signs. They are almost always

Fig. 1. The barium-filled sac of the duodenal diverticulum and its connection with the duodenum are well shown.

overlooked, not only by the clinician but by the surgeon as well and are discovered by the roentgen ray accidentally. Sometimes, they are inflamed, producing diverticulitis, in which instance they give rise to signs and symptoms suggestive and even pathognomonic of duodenal ulcer. Lesions of the gall-bladder and duodenum may be associated with it. When large or surrounded by inflammatory adhesions producing partial obstruction vomiting is a prominent sign. Perforation must be a rare complication. No report of such a case in the American literature has come to my attention. True diverticula should not be confused with secondary dilatations or pouch formations as the result of duodenal stasis, perforated and encapsulated duodenal ulcers or traction pouches formed by adhesions.

CONCLUSIONS

The following points are worth stressing:

1. It is often impossible to make absolute, clinical differentiation between lesions of the gall-bladder, stomach and duodenum, and sometimes of the appendix.

2. A case of duodenal diverticulum perforated into the head of the pancreas is here reported in which the finding of gall-stones was coincidental and not the true cause of the patient's complaint. Proof of this is the persistence of pain and distress after cholecystectomy.

3. Duodenal ulcer was simulated by the relief of pain following administration of soda bicarbonate. It is obvious that regardless of how long the patient was medically treated for ulcer her condition would not have been relieved.

4. The appeal for thorough roentgen examination is well justified in all obscure, upper, gastrointestinal disorders. Discovery of the true cause will amply reward the roentgenologist for his systematic and painstaking search, provided these obscure lesions are constantly borne in mind.

Fig. 2. The stomach and the small intestines are empty but the sac is still full and its neck clearly outlined.

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EDITORIAL

CONCERTED ACTION IN THE FIGHT AGAINST CANCER

IT IS generally conceded that the death rate from malignant disease now holds second place in mortality statistics, being next to cardiac disease and its associated conditions in frequency. Despite improved methods of treatment with resulting gain in the number of cures, the increasing incidence of malignancy is more than keeping pace. Better palliative results will not reduce final death rate, although they are of inestimable value. The increasing incidence and mortality must be fought by even greater percentages of actual cures. Everyone who has made a study of the subject agrees that there are only three points of attack to bring this about: still further improvement in the techniques of our present methods, a more widely executed early recognition of malignancy and research which will lead to a better understanding of neoplastic disease, and a discovery of its cause and possibly the elaboration of some new and successful form of treatment.

From another point of view, cancer and allied conditions comprise a very important economic problem under existing circumstances. The patient must submit to expensive methods of treatment if he is to pay his own way. He is very often deprived of his ability to work for a variable period of time, depending upon the kind and duration of treatment necessary and the chances of recovery. His family is often made responsible for his care and even his support. If he must become an object of charity, some institution must assume the cost of expensive treatment and even his keep and care for a variable time. No other disease requires such costly and complex methods of treatment. Cancer is not a condition which can be ameliorated or cured by changed hygienic conditions or modes of living.

It is most gratifying to know that a semi-organized fight against malignancy has been started by a host of individual units. National, state and local medical societies, and state and municipal health boards have had their interests aroused and are doing much good work. Even the Federal Government has shown signs of interest. Concerted action to bring about the greatest possibilities must originate from definite preconceived plans which have been worked out carefully and judiciously. Two medical groups, the American Society for the Control of Cancer and the Committee on the Treatment of Malignant Disease of the American College of Surgeons, have formulated basic plans which seem rational as a basis for future organized work. Their recommendations do not conflict with but make use of the groups or individuals who are working on the cancer problem at the present time. The recommendations of the two bodies are quite similar in essential or major details. We as radiologists must play a most important part in the success of treatment and we must direct every effort toward the most advantageous use of the means at our command. At the same time we must realize that we are but individual members of larger groups engaged in a work which requires concerted action.

In 1927, the American Society for the Control of Cancer appointed a committee composed of Drs. Ewing, Greenough and Gerster to investigate the methods of treatment of cancer in this and other countries and to offer a report upon the methods in general and suggestions for the betterment of the handling of cancer patients. Their

recommendations,[1] especially in regard to group methods, are worthy of our attention, and will be presented in abstract form, with modifications and comment.

Cancer treatment and research work is now being carried out and can continue to advantage under the auspices of the following agencies:

1. Cancer institutes or special cancer hospitals, under state, municipal or private organization.
2. Organized cancer services in general hospitals.
3. Unorganized cancer services in general hospitals.
4. Private or unattached physicians, surgeons or radiologists.
5. Cancer homes.

1. *Cancer Institutes.* This is generally recognized as actually or potentially an ideal organization for dealing with the problem from all angles. The Memorial Hospital in New York City and the State Institute for the Study of Malignant Disease in Buffalo are excellent examples. It has been suggested that at least two such institutes should be established in each large state and so located as to make them accessible to the greatest possible number of patients. The accumulation of a staff capable of caring for all of the problems from the standpoint of skill, efficiency and experience may or may not require location in a medical center, though it will usually be desirable. Such institutions require heavy endowments. Sufficient money is of paramount importance, and without it the problem cannot be attacked in a satisfactory manner. Such an institution must be represented on its staff by a general surgeon, an oral surgeon, a gynecologist, urologist, internist, dermatologist, laryngologist, radiologist, pathologist and physicist, for one or more of these specialists must be concerned in the treatment of every case. There must be a complete laboratory service with the appropriate personnel, which may have to include a biologist and a biochemist. There must be an adequate clerical force, and social and educational services should be incorporated in the working force. Roentgen-ray and diathermy equipment must be complete and of the best, and must be kept up-to-date. A sufficient quantity of radium is most essential.

Such an institute may be advantageously affiliated with a university, but most of us cannot but agree that complete university control is often undesirable.

Cancer hospitals without the complete organization and equipment of the institute plan are not so efficient and may require affiliation with an institute or cancer research laboratory.

2. *Organized Cancer Services or Clinics in General Hospitals.* Such a service may have the organization and equipment of an institute on a smaller scale, but this is not often the case. It should have some affiliation, if possible, with an institute. Its success or failure will depend upon its staff, clerical force, equipment available, its source of funds, and, above all, upon the good will and cooperation of the entire institutional staff. It should have referred to it and have the disposition of all malignant cases admitted to the institution. The frequent friction created by those outside the service or clinic who are loath to give up what they regard as their inherent right to the treatment of certain cases is always detrimental to the greatest good to the patients.

3. *Unorganized Cancer Service in General Hospitals.* This is probably the most frequent type of organization engaged in the treatment of malignant disease. Most of us, as radiologists, play a part in the department which deals with the radiological problem in such institutions. Often the complete handling of a case may be carried out to entire satisfaction in that department, but a large number of the patients are referred for radiological treatment from the other members of the institutional staff. The success of treatment

[1] Ewing, J., Greenough, R. B., and Gerster, J. C. A. The medical service available for cancer patients in the United States; suggestions for its improvement. *J. Am. M. Ass.*, 1929, *93*, 165–169.

under these circumstances will depend upon the skill and experience of the clinical and laboratory members of the staff, and the spirit of cooperation in the institution, on the one hand, and on the other, upon the radiological staff and their equipment. The latter must be of the best, which it very often is not, as many hospitals do not realize the importance of this feature. There should be an adequate supply of radium, sufficient to care for all cases referred to the institution for such treatment. A proper endownment will be frequently necessary to keep such a department adequately equipped because it bears the brunt of expense from many other services of the hospital. The members of the radiological staff, at least, should be affiliated, if possible, with a group one or two institution.

The Committee on the Treatment of Malignant Disease of the American College of Surgeons, having been entrusted by the Board of Regents, in 1929, with the task of perfecting details leading to the promotion of cancer service in this country,[2] has pledged itself to attempts for the betterment of organization and equipment in both organized and unorganized cancer services in general hospitals. It would seem that the promotion of these groups offers the best method of attack in the immediate future.

The American Medical Association, through its Council on Medical Education and Hospitals and a Committee in Radiology and Roentgenology is working toward the standardization of departments of radiology in hospitals.

It would certainly seem advisable to persuade institutions to improve their radiological departments to a required standard or to limit the work of those departments to the treatment of only such cases as they can care for adequately.

4. Private Physicians, Surgeons and Radiologists. It is highly desirable that such individuals have the proper skill and experience in handling cases coming within the province of their line of work. They should not have single track minds but should always be willing to seek cooperation where it is distinctly to the patient's advantage. Many individuals coming under this classification have affiliations with either group one or two institutions, which is to the mutual advantage of themselves and their patients.

5. Cancer Homes. Such institutions fulfill urgent needs. They serve to best advantage when affiliated with institutions whereby the usual advanced cases can be furnished with adequate palliative and occasionally curative treatment and where experienced cooperation may be obtained, various studies in an important field pursued on what are often ideal types of cases, and autopsy material used to good advantage. The cancer home, even with its "comforts of home," but without being able to give its inmates every chance, and without furnishing the proper opportunities for study of the disease, fails lamentably in its broader service to mankind.

Both the American Society for the Control of Cancer and the American College of Surgeons, through its Committee on the Treatment of Malignant Disease, Department of Clinical Research, are ready to assist in many ways in the promotion of cancer clinics in general hospitals, either in the organized form such as group two or as a cancer diagnostic clinic. The latter form may be defined as a group usually connected with an institution in a smaller community where there are sufficient professional skill and resources for a diagnostic clinical service but modern roentgen-ray equipment and especially radium are not available. Such a body should be representative of as many specialities concerned in cancer treatment as possible. The function of such a group would be somewhat as follows:

1. To encourage outside practitioners who are not so familiar with malignant disease to bring their patients to the clinic.

2. To provide a more certain diagnosis.

[2] Organization of service for the diagnosis and treatment of cancer. Recommended by the Committee on the Treatment of Malignant Disease, American College of Surgeons. *Surg., Gynec. & Obst.*, October, 1930, *51*, 570–574.

3. To offer group judgment on the best method of treatment.

4. To advise the physician bringing the case as to the best course to pursue.

5. To educate the local medical profession and the public.

The Cancer Research Laboratory is capable of much valuable research work and such organizations are worthy of being fostered in various medical centers. Well-known examples are the ones connected with Columbia University and the Rockefeller Institute. Naturally they require adequate endowments.

Among all of the various organizations now actively engaged in the fight against cancer, and especially those doing research work, there is considerable duplication of effort. In order to obviate this waste of time, energy and the resulting expense, a subcommittee of the Senate Committee on Commerce, during the last session of Congress, invited several men interested in cancer to meet with them for the purpose of formulating a bill for presentation to Congress authorizing the Surgeon General of the United States Public Health Service to make a survey of the entire subject similar to those made by the two medical organizations previously mentioned. Representatives from both organizations were present. Naturally the Surgeon General's office would be a very valuable cooperative body and could act as a clearing house where valuable data would be available, without duplication of expensive investigation.

HENRY K. PANCOAST

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. John T. Murphy, 421 Michigan St., Toledo, Ohio.
Thirty-second annual meeting: Atlantic City, N. J., 1931.

American College of Radiology
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual Meeting: Philadelphia, 1931.

Section on Radiology, American Medical Association
Secretary, Dr. G. W. Grier, Jenkins Arcade, Pittsburgh, Pa.
Annual meeting: Philadelphia, June 8–12, 1931.

Radiological Society of North America
Secretary, Dr. I. S. Trostler, 812 Marshall Field Annex, Chicago, Ill.
Sixteenth annual session: Los Angeles, Calif, Dec. 1–5, 1930.

Radiological Section, Los Angeles County Medical Society
Secretary, Dr. Orville N. Meland, 1407 S. Hope St., Los Angeles.
Meets on the third Wednesday of each month at the California Hospital.

Radiological Section, Southern Medical Association
Secretary, Dr. W. S. Lawrence, Medical Arts Bldg., Memphis, Tenn.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

Chicago Roentgen Society
Secretary, Dr. George M. Landau, 660 Groveland Park.
Meeting second Thursday of each month October to May inclusive at Virginia Hotel.

Cleveland Radiological Society
Secretary, Dr. A. Srauss, 518 Medical Arts Bldg.
Meetings are held at 6:15 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Central Illinois Radiological Society
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

Milwaukee Roentgen Ray Society
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee.
Meets first Friday in October, December, February and April.
Place of meeting designated by the president.

Minnesota Radiological Society
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.
Next meeting to be announced.

New England Roentgen Ray Society
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

New York Roentgen Society
Secretary, Dr. J. Bennett Edwards, Englewood Hospital, Englewood, N. J.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

Central New York Roentgen Ray Society
Secretary, Dr. D. S. Childs, 316 Gurney Bldg., Syracuse, N. Y.
Three meetings a year—April, August and November.

Pacific Coast Roentgen Ray Society
Secretary, Dr. Harold B. Thompson, Seattle, Wash.
Two meetings a year.

Pennsylvania Radiological Society
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Next meeting, Penn. McKee Hotel, McKeesport, Pa., May 13–14, 1931.

Philadelphia Roentgen Ray Society
Secretary, Dr. Karl Kornblum, 3400 Spruce St.
Meeting first Thursday of each month from October to May inclusive, at 8:15 p.m., in Thomson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Camp C. Thomas, 476 Lake Ave.
Meets monthly on the first Friday evening at 7:45 at the Rochester Medical Association Building.

St. Louis Roentgen Club
Secretary-Treasurer, Dr. L. R. Sante, Missouri Building.
Meets first week of each month. Time and place of meetings designated by president.

Texas Radiological Society
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Roentgen Ray Society
Secretary, Dr. D. M. Clark, University Hospital, Ann Arbor, Mich.
Meets every Wednesday evening from September to July, at 7:30 o'clock in the amphitheatre of the University Hospital.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

VIRGINIA ROENTGEN RAY CLUB
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.
Next meeting, to be announced.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA
Secretary, Dr. Francisco Padron, Enrique Villuendas 64, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch.
Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIETE DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE.
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SÜD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE ROENTGENGESELLSCHAFT
Meets annualy in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Nicolae Busila, 44 Elizabeta Blvd., Bucarest.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly on the first Monday at 8 o'clock in the State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. A. Elektorowicz, 19 Hoza St., Warsaw.
Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. O. Wissing, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets on the first Tuesday of each month from October to July.

MINNESOTA RADIOLOGICAL SOCIETY

A meeting of the Minnesota Radiological Society was held at the University Hospital Minneapolis, Minn., on October 25, 1930. The following program was presented: "Roentgen Studies on the Onset of Lobar Pneumonia" by Walter H. Ude, M.D., Minneapolis. "Childhood Tuberculosis" by Malcolm B. Hanson, M.D., Minneapolis. "Lympho-epithelioma" by A. U. Desjardins, M.D., Rochester. "Air Injection in the Diagnosis of Lesions of the Colon" by Harry M. Weber, M.D., "Roentgen Therapy in Carcinomatous Metastases to Bone" by K. W. Stenstrom, Ph.D., and L. G. Erickson, M.D.

An informal dinner was held at the Town and Country Club, Dr. W. A. O'Brien acting as toastmaster. The Society was honored by the presence of two distinguished guests, Dr. James L. Martin of Dallas, Texas, and Dr. Bernard H. Nichols of Cleveland, Ohio. The following papers were presented: "Significance of Small Intestinal Gas in the Diagnosis of Bowel Obstruction" by Edward Schons, M.D., St. Paul. "Clinical and Experimental Studies on Intestinal Obstruction" by Owen H. Wangensteen, M.D., Minneapolis. "Intravenous Urography" by Bernard H. Nichols, M.D., Cleveland, Ohio.

At the business meeting new officers were elected for the coming year as follows: Dr. B. R. Kirklin of Rochester, President; Dr. Gage Clement of Duluth, Vice-President, and Dr. Leo G. Rigler of Minneapolis, Secretary-Treasurer.

The time and place of the next meeting will be decided by the Executive Committee at an early date.

Leo G. Rigler, *Secretary*

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

Das Ulcusproblem in Lichte moderner Röntgenforschung. Von Priv.-Doz. Dr. H. U. Albrecht, Oberarzt der medizinischen Universitats-Klinik, Frankfurt a. M. Paper. Price, M. 10. Pp. 79, with 116 illustrations. Leipzig: George Thieme, 1930.

We wonder how many roentgenologists are entirely satisfied with their gastrointestinal examinations. Are the diagnoses of ulcer accurate to a high degree and do they include sufficient information to be of great value to the clinician in the treatment of his patient? If you are largely dependent on bulbar irregularity for the detection of duodenal ulcer, you may, according to Dr. Albrecht's experience, be missing nearly 50 per cent of the lesions. You will find much to challenge your attention in this small book and a careful study of the tables and discussion should materially raise the standards of your work.

The author has analyzed the histories of a series of 363 cases of gastric and duodenal ulcer with respect to incidence in general, relative frequency of the two conditions, age and sex of the patient, heredity periodicity, and the occurrence of hyperacidity and hemorrhage. He has reviewed the roentgen findings in respect to location of the ulcer, multiplicity, occurrence of the niche, deformity, stenosis, and so forth.

The thoroughness of his examinations may be judged by the fact that 23.7 per cent of all gastrointestinal studies were positive for peptic ulcer, and that in 90 per cent of these the niche or crater was demonstrated. Such a high percentage of satisfactory positive diagnoses is due to his careful study of the mucosal folds with a small meal, accompanied by films made at various angles.

It is interesting to note that in the series of 1527 examinations, there were 769 with positive organic lesions. We find it difficult to explain some of the statistics, for example, those of diverticulosis. Although 30 cases of duodenal diverticulosis were discovered only one case showed colonic diverticula. This being at variance with the experience of others may indicate lack of care in examination of the colon but in no way discredits the remarkable pains with which the upper tract is studied.

Dr. Albrecht discusses many phases of the ulcer problem. He stresses the presence of gastritis as a usual accompaniment of ulcer and its importance in prognosis and treatment. He emphasizes the fallacy of assuming a cure with cessation of pain or of assuming the persistence of ulcer merely on evidence of a deformed bulb, the niche being the one positive sign.

A note of optimism is sounded in regard to the cure of large gastric and duodenal ulcers, cases being cited and illustrated in which large craters disappeared after only six weeks of medical treatment. However, the reader is warned against harmful procrastination in the use of surgery in those cases which prove refractory to stringent medical measures. The poor results of surgery and the recurrences which make many afraid to employ it are, Albrecht thinks, chiefly due to a failure to diagnose and treat the accompanying gastritis.

The work contains profuse illustrations and the reader will find himself not only interested in studying them but stimulated to the production of like results.

E. W. Hall

X-Ray Crystallography. By R. W. James, M.A., B.Sc., Senior Lecturer in Physics in the University of Manchester. Cloth. Price, $1.15. Pp. 88, with 29 illustrations. New York: E. P. Dutton & Co., Inc., 1930.

To the average medical roentgenologist this small monograph would hardly commend itself for the simple reason that it treats of a specialized domain far removed from his own sphere of interest. He can with all justification excuse himself on the score of more immediate preoccupations and of inadequate preparation for venturing even a glance into the difficult subject of x-ray crystallography.

However, an intellectual adventure lies in store for him who has the curiosity and willingness to hurdle mental rigidities and brush up enough on geometry and physics to read this book understandingly. It gives an outline in

five chapters of the main principles underlying methods of analyzing crystals by means of x-rays and is intended to serve as a general introductory account of the subject for students of physics.

When he is finished the reader will not know how to interpret an x-ray spectrogram nor why an atom should possess vibrational energy at absolute zero. But he will have gained an insight into the reasoning and methods whereby these much talked of but little-known rays have made visible the ultimate structure of matter and in a sense illuminated their own structure. He may even perceive that x-ray crystallography is perhaps not so remote from medical roentgenology after all.

B. Cohen

Radiumtherapie, Methoden und Aussichten. Dr. F. Gudzent, a.o. Professor an der Universität Berlin. Volume V of Medizinische Praxis. Edited by Grote, Fromme, Warnekros. Pp. 106, with 53 illustrations. Price: Paper, 6.50 Marks; Bound, 8 Marks. Dresden: Theodor Steinkopff, 1929.

Gudzent was one of the first in Germany to study the clinical application of radium and other radioactive substances. In this monograph, he has succeeded in presenting a concise review of the physics, biologic effects, technique of application, and the therapeutic results obtained in the diseases amenable to treatment by radioactive preparations. The concluding chapter discusses "professional" injuries which have been observed particularly among the early workers. The safety rules adopted by the International Congress in Stockholm are also mentioned. This little book should appeal to the general practitioner as well as to the radiologist because it is easy to read and because the great experience of the author is evident throughout the text.

Ernst A. Pohle

Ultra-Violet Radiations and Their Uses. By Robert Aitken, M.D., F.R.C.P.E., Lecturer on Diseases of the Skin, Edinburgh University; Assistant Physician, Skin Department, and Physician in Charge Dermatological Light Department, Royal Infirmary, Edinburgh, etc. Cloth. Price 18/6. Pp. 208, with 15 illustrations. Edinburgh: Oliver and Boyd, 1930.

This book, dedicated to "Sufferers from Lupus," is introduced by Sir Norman Walker, the founder of the first clinic for general radiation treatment in Scotland. The history, physics of radiation, physico-chemical action of ultraviolet rays, the biological and pathological effects of light, the theories of action, the apparatus, the technique and dosage are discussed first. Then follow the clinical chapters beginning with indications, contraindications, and risks of the treatment. The diseases are partly subdivided according to organs and partly follow the specialties in medicine. The last chapter deals with abuses of radiations and their uses in dentistry, veterinary surgery, and farming. Irradiated food stuffs are briefly mentioned. The author is rather skeptical as to the value of ultraviolet transmitting glass for clinical purposes. A brief bibliography concludes the book. The illustrations show mostly the different types of apparatus used for light therapy in England; a few are photographs of patients before and after treatment.

The conservative attitude of the author and the practical nature of this treatise recommend it to the physician interested in ultraviolet radiation.

Ernst A. Pohle

BOOKS RECEIVED

Das Ulcusproblem im Lichte moderner Röntgenforschung. Von Priv.-Doz. Dr. H. U. Albrecht, Oberarzt der medizinischen Universitäts-Klinik, Frankfurt a. M. Paper. Price, M. 10. Pp. 79, with 116 illustrations. Leipzig: Georg Thieme, 1930.

Otologische Röntgendiagnostik. Von Dr. Ernst G. Mayer, Privatdozent für Röntgenologie, Assistent am Zentralröntgeninstitut, Professor G. Holzknecht, Wien. Klinischer Beitrag: Die Wertung und Verwendung der Röntgenbefunde in der Otologie. Von Dr. Karl Eisinger, Assistent und röntgenologischer Referent der Univ.-Klinik fur Ohren-, Nasen- und Kehlkopfkrankheiten, Professor Dr. H. Neumann, Wien. Paper, price Rm. 75.00; bound, price Rm. 78.60. Pp. 357, with 611 illustrations and 6 tables. Wien: Julius Springer, 1930.

Allgemeine Grundlagen. Physik und Technik des Röntgenverfahrens. (Radiologische Praktika. Band XIV). Von Dipl.-Ing. M. Brenzinger, A. Janitzky und Dr. E. Wilhelmy, Universitäts-Institut für physikalische Grundlagen der Medizin zu Frankfurt a. M. Cloth. Price, Rm. 25.50. Pp. 237, with 275 illustrations. Leipzig: Georg Thieme, 1930.

Das Röntgenverfahren. Ein Lehrbuch für den Arzt und die technische Assistentin. Von Dr. Kurt Kirschmann, Facharzt fur Röntgenologie in Berlin. Paper, price 23 Marks; bound, price 26 Marks. Pp. 345, with 283 illustrations. Leipzig: Georg Thieme, 1930.

La roentgentherapie; ses indications cliniques. By Dr. Iser Solomon, radiologiste de l'Hopital Saint-Antoine. Paper. Price, 20 fr. Pp. 208, with 14 illustrations. Paris: L'Expansion Scientifique Française, 1930.

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

Head

HAAS, LUDWIG: On the clinical application of roentgen suture diagnosis 698

HAHN, OTTO, and KUHLENBECK, HARTWIG: Defects of the septum pellucidum in the encephalogram 698

STANKIEWICZ, ZYGMUNT: An important simplification of the graphic method of localization of Grudzinski 698

BERRY, GORDON: Further observations on dental caries as a contributing factor in maxillary sinusitis 698

BAUM, HARRY L.: A new apparatus for roentgenography of the sinuses 699

PALMER, DORWIN L.: Roentgenology of the accessory nasal sinuses 699

JONES, E. LLOYD: Iodized oil as an aid in the diagnosis of chronic maxillary sinus disease 699

Neck and Chest

VOLLMAR, F.: The azygos lobe of the right lung and its clinical significance 699

OTT, AD.: Experimental contribution to the roentgen diagnosis of miliary pulmonary tuberculosis 700

SIEBERT, WERNER W.: The description of pathologic lung shadows in terms of clouds 700

BERNARD, LÉON: The intercleido-hilar onset of pulmonary tuberculosis 700

WOLFF, ERNST, and STONE, ROBERT S.: Chest roentgenograms of nontuberculous children suspected of being tuberculous 701

STOLOFF, E. GORDON: Pleurisy in infants and children 701

MARKO, D. The diagnosis of pleural adhesions 701

PATERSON, RALSTON: The roentgenological aspects of empyema 701

BROC, RENÉ, and JAUBERT DE BEAUJEU, A.: Two interesting cases of hydatid cysts of the lungs 702

SCHULTE, G.: Pneumoconiosis of the Ruhr miners and lung carcinoma 702

VAN ALLEN, C. M., and ADAMS, W. E.: The mechanism of obstructive pulmonary atelectasis 702

CORYLLOS, POL. N.: Postoperative pulmonary complications and bronchial obstruction. 702

ARMAND-DELILLE, P.-F., and LEUNDA, J.: Intrabronchial injection of lipiodol in children by means of a new technique 703

LEPENNETIER, F., and ALTMAN, J.: Foreign bodies in the bronchi 703

LLOYD, JOHN J.: Broncholiths 703

KLASON, T.: On the horizontal orthoprojection of the heart 704

MEYER-BORSTEL, H.: Changes in the form and size of the heart in struma 704

ARKUSSKY, J.: The roentgen characteristics of the functional capacity of the heart ... 704

IMPERATORI, CHARLES J.: Cardiospasm 705

Abdomen

BEILIN, D. S.: When has visceroptosis clinical significance? 705

WINKELSTEIN, ASHER: Some clinical features of air swallowing 706

RIGLER, LEO G.: Roentgenologic observations on benign tumors of the stomach 706

EINHORN, MOSES: Anatomical consideration of the ulcer bearing area (lesser curvature of the stomach, pylorus and first part of the duodenum) 707

CAMP, JOHN D.: Further observations on the direct roentgenologic signs of gastrojejunal and jejunal ulcer 707

MATZ, PHILIP B.: A study of intestinal tuberculosis among ex-service men 707

BRUNN, HAROLD, and RHODES, GEORGE K.: Acute hematogenous (metastatic) perinephric abscesses 708

KAUFMANN, ROBERT, and MME. KAUFMANN: On the lipiodol roentgen diagnosis of lesions of the biliary tract in fistulae 709

MURPHY, GEORGE T., and HIGGINS, GEORGE M.: The emptying of the gallbladder following restoration from acute experimental cholecystitis 709

Gynecology and Obstetrics

GRIER, G. W.: The value of a lateral view in diagnosis of pregnancy 709

JARCHO, JULIUS: Roentgenographic examination of the female pelvic organs 709

Genitourinary System

THOMPSON, GERSHOM J., and BUMPUS, HERMON C. Jr.: Ureteral kinks; how they occur at the order "take a deep breath and hold it" 710

MARTIUS, H.: Female genital actinomycosis.. 710

Nervous System

DAVIS, LOYAL, HAVEN, HALE A., and STONE, THEODORE T.: The effect of injections of iodized oil in the spinal subarachnoid space 710

Skeletal System

Wagner, Aage: Isolated aseptic necrosis in the epiphysis of the first metatarsal bone 710
Jansson, Gösta: Osteochondritis dissecans (König) considered from the roentgenologic point of view 711
Baumann, Ernst: On simulated horizontal division of vertebral bodies in the roentgenogram 711
Schoenthal, Ludwig, and Burpee, Claude: Renal rickets 711
v. Albertini, A.: Remarks on sarcomatous degeneration of osteitis deformans 712
Stone, Robert S.: Echinococcic involvement of bone 712
D'Istria, A.: Erosion of the vertebrae from aneurysm 712
Denier: Healing of a giant tuberculous ulcer of the leg 713

Blood and Lymph System

Mandeville, F. B.: Roentgen-ray findings in erythroblastic anemia 713

MISCELLANEOUS

Mulder, Denis: New results of roentgenology, teleroentgenograms and roentgenograms of the entire body 713
Bouchacourt, L.: What are the principles that led me to the conception and to the construction in 1919 of my bonnet No. 4 utilizing two tubes and two screens placed at right angles and permitting a true endoscopy of the fractured or subluxated extremity by the use of a mirror reflecting one of the two images? 714
Belot, J.: Integral protection; new improved model, 1930 714

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

HAAS LUDWIG. Ueber die klinische Verwertbarkeit der röntgenologischen Nahtdiagnose. (On the clinical application of roentgen suture diagnosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1930, *41*, 549–571.

After an analysis of the appearance of the cranial sutures in various anatomic specimens and in the living, the author found that the roentgen appearance does not always coincide with the anatomic appearance. Thus the serrated sutures (seen in the usual roentgenograms of the skull) are not formed by the whole of the suture but only by the part of the external table. The part corresponding to the internal table, the so-called lamina vitrea, is nearly always straight and ossifies much sooner. From a practical standpoint this means that an obliteration of the suture may occur sooner than can be diagnosed from the appearance of the serrated line. On the other hand, an obliterated serrated suture does not necessarily indicate a union of the lamina vitrea.

The pathologic changes observed in connection with sutures may be classified into three groups: those of delayed, those of irregular and those of accelerated obliteration. These three groups are discussed in detail.—*T. Leucutia.*

HAHN, OTTO, and KUHLENBECK, HARTWIG. Defektbildungen des Septum pellucidum im Enzephalogramm. (Defects of the septum pellucidum in the encephalogram.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1930, *41*, 737–742.

The authors describe a case of a woman aged thirty-five, who on encephalographic examination presented rather peculiar rounded areas in the region of the ganglia overlapping the injected lateral ventricles. A clinical diagnosis of cystic formations of the choroid plexus was made but at post mortem a multiple perforation of the septum pellucidum was found. In connection with this unusual case the authors discuss the defects of the septum pellucidum which are (1) perforations; (2) entire absence with otherwise normal corpus callosum and fornix, and (3) absence of the septum and of the corpus callosum. These malformations of the septum pellucidum are sequels of developmental anomalies.

The authors include photographs of 2 rare specimens from the anatomic museum of Breslau, one of them showing a perforation of the septum pellucidum and the other a complete absence of the septum with an otherwise normal brain.—*T. Leucutia.*

STANKIEWICZ, ZYGMUNT. Eine wichtige Vereinfachung der graphischen Lokalisationsmethode von Grudzinski. (An important simplification of the graphic method of localization of Grudzinski.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1930, *41*, 639.

The method of Grudzinski for the graphic localization of foreign bodies of the eye (see abstract, this Journal, April, 1930, p. 436) was modified just previous to his death. In this article the modification is briefly described.

Instead of taking roentgenograms on separate films and then superimposing them on one film as was done previously, it is now recommended that two roentgenograms (with half time exposures) be made on one film. Thus the following roentgenograms are taken: (1) a single profile view of the orbit with the eye looking upwards; (2) double exposure on the same film with the eye looking upwards and downwards; (3) a single exposure with the eye looking to the right, and (4) double exposure with the eye looking to the right and left. The rest of the procedure remains unchanged. —*T. Leucutia.*

BERRY, GORDON. Further observations on dental caries as a contributing factor in maxillary sinusitis. *Arch. Otolaryngol.*, Jan., 1930, *11*, 55–62.

The paper is a plea to the rhinologist to consider gross dental pathology during his study of a patient suffering from sinus disease especially with disease of the maxillary sinuses. The author analyses 73 cases of acute and chronic maxillary sinus disease and out of that group he feels at least 60 per cent were of

dental origin. The author uses all laboratory data in making his diagnoses—but puts most of his reliance on transillumination which he describes in detail. He reports 3 cases to illustrate the points that he brings out in his presentation.—*E. P. Pendergrass.*

Baum, Harry L. A new apparatus for roentgenography of the sinuses. *Arch. Otolaryngol.*, Jan., 1930, *11*, 90–94.

An excellent and easily adaptable piece of apparatus is described for making films of the sinuses in the erect posture. The article is well illustrated and anyone doing sinus work would enjoy reading the details of this new apparatus and the ease with which the examination is made.—*E. P. Pendergrass.*

Palmer, Dorwin L. Roentgenology of the accessory nasal sinuses. *Am. J. Surg.*, March, 1930, *8*, 657–660.

The author in a short and comprehensive article states that flat or stereoscopic films in the posteroanterior direction after the manner of Waters gives sufficient dependable information regarding the maxillary antra and the frontal cells. In his experience stereoscopic films in the Rhese position is the most valuable method for the routine study of the sphenoids and ethmoids, especially when combined with a study made after the injection of contrast media.

The author stresses the necessity for the roentgenologist to correlate the operative findings with those found on technically perfect roentgenograms. If this is done the roentgenologist will in time be able to give valuable assistance to those referring cases for study.

The types of sinus disease are adequately discussed and divided into two classes: (1) those showing increased density, and (2) those showing structural changes.—*E. P. Pendergrass.*

Jones, E. Lloyd. Iodized oil as an aid in the diagnosis of chronic maxillary sinus disease. *Arch. Otolaryngol.*, April, 1930, *11*, 475–484.

In the diagnosis of chronic maxillary sinus disease, the most reliable means of investigation are lavage and roentgen examination. In cases in which lavage is negative, and in those in which the roentgenogram shows bilateral clouding of such a nature that it is interpreted as negative by the roentgenologist, injection of a contrast medium and outlining the sinus approaches information obtained in actual exploration of that cavity.

Technique. After preliminary study and routine roentgenography, the antrum is punctured beneath the inferior turbinates with a small trocar. Irrigation may or may not be instituted. Iodized sesame oil 40 per cent is introduced into the sinus until the oil drips from the nose. The head is tilted slightly forward and care is taken not to introduce the oil beneath the mucous membrane. No pack is placed in the nose. The patient is examined roentgenographically within ten to fifteen minutes. The author states that the rhinologist should not hesitate to make his own interpretation but that correlation of the findings by the rhinologist and roentgenologist is helpful.

Results. The size, shape and capacity of the antrum can be determined. The normal antrum contains 7–12 c.c. of the oil; a small antrum may contain 3 to 6 c.c. oil; a pathological antrum 1–5 c.c. The emptying time of a normal antrum is less than forty-eight hours. Any delay is pathological. Three months is the longest time observed by the writer.

Thickening of the mucous membrane and polypoid formation can be observed. Changes in appearance can be determined by repeated examinations. Cysts can be demonstrated by this method although they transilluminate clearly.

The indication for the use of the oil is whenever doubt exists as to the nature or presence of disease of the sinus. The iodized oil should not be used in patients who have toxic goiter, active tuberculosis or iodine hypersensitivity. Brominized oil will eliminate the above contraindications.—*E. P. Pendergrass.*

NECK AND CHEST

Vollmar, F. Uber den Lobus azygos der rechten Lunge und seine klinische Bedeutung. (The azygos lobe of the right lung and its clinical significance.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1930, *41*, 731–737.

Ten cases of azygos lobe were observed during the period of a few weeks, 2 of which were of special interest. In the first, that of a woman aged twenty-five, a tuberculosis of the right apex was previously diagnosed, whereas the opacity was found to be due to partial atelectasis of the azygos lobe. In the second case, that of a boy six years of age, following a pneumonia of the right lower lobe an abscess in the

right apex developed which could not be diagnosed otherwise than by assuming the presence of an azygos lobe. After a healing of the lesion, roentgenograms confirmed the assumption. Thus a knowledge of azygos lobe is important since it may be the seat of various pathologic lesions.—*T. Leucutia.*

OTT, AD. Experimenteller Beitrag zur Röntgendiagnose der miliaren Lungentuberculose. (Experimental contribution to the roentgen diagnosis of miliary pulmonary tuberculosis.) *Forschr. a. d. Geb. d. Röntgenstrahlen*, March, 1930, *41*, 404–413.

The author performed a number of experiments in order to determine the part played by the superimposition of the tubercles in the roentgen appearance of miliary pulmonary tuberculosis. For this purpose he used pills of paraffin and lanolin or sugar which he arranged in layers of various thicknesses and roentgenographed. It was found that the summation effect produced by the superimposition of the pills is of considerable importance. The assumption of Dehn and Weinschenk that the main effect is due to secondary rays could not be verified.

The conclusion is reached that the roentgen appearance of miliary pulmonary tuberculosis is characterized chiefly by the summation effect of the small tubercles falling in the line of the roentgen beam, the tubercles nearest to the film appearing the sharpest.—*T. Leucutia.*

SIEBERT, WERNER W. Wolkennamen zur Beschreibung der pathologischen Lungenverschattungen. (The description of pathologic lung shadows in terms of clouds.) *Forschr. a. d. Geb. d. Röntgenstrahlen*, May, 1930, *41*, 756–767.

The author recommends that the shadows observed in various pulmonary lesions be described by applying the terms generally used in meteorology for the differentiation of the clouds. The following three types are proposed for the designation of the fundamental lesions: (1) stratus (st.) indicating a shadow characterized by relatively great horizontal extension, as "a layer of cloud"; (2) cumulus (cu.) indicating massive clouds of rounded or polygonal shape, as in "banks of clouds," and (3) cirrus (ci.) indicating streaks or lines of clouds running parallel or intersecting. In addition to these three main groups, two transitional forms are distinguished: (4) cumulocirrus (cu-ci.) and (5) cirrocumulus (ci-cu.), both being forms of cumulus and cirrus with the one first named predominating.

In describing the various forms the ending of "ous" is used (as for example cumulous) except in cirrus, where "oid" (cirroid) is used in order to differentiate from cirrhous, a term already used for other purposes.

If there is an association of several of the above groups they are indicated by describing the most predominating first and then all the rest afterward as, for example, stratus+cumulus (st.+cu.), stratus+cirroid (st.+ci.), etc.

A further descriptive accuracy is furnished by indicating the following characteristics: (*a*) size of individual shadows (as, for example, small or large cumulus); (*b*) sharpness of outline; (*c*) intensity; (*d*) structure; (*e*) number; (*f*) distribution and general appearance.

The following shadows cannot be included in the above classification and must be described separately: (*a*) ring shadows; (*b*) increased transparencies; (*c*) interlobar bands, and (*d*) hilar and root shadows.—*T. Leucutia.*

BERNARD, LÉON. Le début intercléido-hilaire de la tuberculose pulmonaire. (The intercleido-hilar onset of pulmonary tuberculosis.) *Presse méd.*, March 15, 1930, *38*, 373–376.

The author uses the name of "intercleido-hilar zone" for the designation of the region which on the roentgenogram appears between the hilus and the clavicle. By means of numerous studies he found that this region plays a very important part in the early diagnosis of tuberculosis and that consequently its closer investigation is of prime importance.

Fourteen cases are described briefly (some of the roentgenograms being reproduced) in which an early diagnosis of tuberculosis was possible by the study of the intercleido-hilar zone. It was found that involvement of this zone always occurs in young individuals and that all stages from a very discrete process to extensive ganglio-pulmonary involvement may be encountered.

The roentgen study of the intercleido-hilar zone is important since physical examination and auscultation as a rule fail to detect the presence of even larger lesions and since it permits certain conclusions with regard to the therapeutic measures to be applied (artificial pneumothorax).—*T. Leucutia.*

Wolff, Ernst, and Stone, Robert S. Chest roentgenograms of nontuberculous children suspected of being tuberculous. *J. Am. M. Ass.*, Feb. 15, 1930, *94*, 458–461.

In order to obtain criteria for the normal child's chest a number of tuberculin negative children from the children's chest clinic of the University of California Hospital and from the Institute of Child Study were studied clinically and roentgenographically. It was concluded that normal children may show axial vessel shadows in the hila, axial vessel shadows up to 3 mm. in diameter in the parenchyma, localized increases of lung markings and pleural thickenings. Increased lung markings to the upper lobes do not necessarily indicate past respiratory infection.—*G. R. Miller.*

Stoloff, E. Gordon. Pleurisy in infants and children. *Am. J. Surg.*, March, 1930, *8*, 662–674.

Pleural disease is considered under the following headings:

A. Acute pleurisy.
1. Dry or fibrinous pleurisy.
2. Free effusion in the pleurae. (*a*) Serous or non-purulent pleurisy. (*b*) Purulent pleurisy or empyema.
3. Encapsulated effusions. (*a*) Superficial. (*b*) Concealed or deep.

B. Chronic disease of the pleurae.

Acute dry pleurisy shows as a hairline density peripherally. It may occur early in pneumonia. Similar in appearance is the chronic residuum of an effusion.

Free effusion seeks the most dependent site and produces a homogeneous shadow varying in extent, which obliterates the outlines of the diaphragm, costal wall and lung structure. The density is greater than in pneumonia. The mediastinum is displaced to the opposite side in large collections.

Fibrino-plastic exudate contains little free fluid. It shows as a band or ribbon-shaped shadow adjacent to the thoracic wall due to the separation of the lung from the chest wall by fibrino-plastic exudate. This may lie over the upper or lower lobes alone or over both. When there is much free pus the appearance of a free effusion is approximated.

Encapsulation of effusions is decided by infection. The different locations for encapsulated fluid may be superficial or deep. The former are mostly in the axilla, either at base or apex. They show as more or less globular, sharply defined densities. The latter may be diaphragmatic or infrapulmonary, mediastinal, and interlobar. The appearances are determined by the location, but the shadow is always sharply defined and dense.

Chronic disease of the pleurae follows the resolution of pneumonic infiltration, healed empyemas, tuberculous effusions and dry pleurisies. Involvement of the lateral pleurae results in a band-like thickening. The increased density of thickened pleura, the evidence of adhesions and fixation of the diaphragm vary with the extent of pleural involvement.—G. R. *Miller.*

Marko, D. Zur Diagnostik der pleuralen Adhäsionen. (The diagnosis of pleural adhesions.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1930, *41*, 451–454.

Pleural adhesions can be diagnosed not only from the fixed appearance of the diaphragm and contraction of the neighboring organs but also from the deformities of the interlobar septa. The author was able to confirm this by the use of pneumothorax.

In the cases observed by the author the adhesions were localized only to the right upper interlobar septum, but it is probable that similar deformities may occur in all the other septa.—*T. Leucutia.*

Paterson, Ralston. The roentgenological aspects of empyema. *Am. J. Surg.*, March, 1930, *8*, 638–647.

Pleural effusions may be pyogenic or otherwise. The former have a tendency to limitation by adhesions, the latter do not.

The roentgen examination should include fluoroscopy to determine the mobility of a collection in different positions, its outlines and the views in which it is best demonstrated. Roentgenographic exposures should then include a posteroanterior stereo pair in the erect posture, a lateral view and as many oblique views and prone and recumbent views as fluoroscopy indicates.

Cavities and sinuses can be outlined by opaque media which should entirely fill a completely emptied pocket. The medium should be sealed in with collodion. Rapid exposures should be supplemented by pictures taken with the Bucky diaphragm. The condition of the ribs is important.

The points of roentgen diagnosis and differential diagnosis of effusions, purulent and nonpurulent, recent and chronic, are taken up in detail.—*G. R. Miller.*

BROC, RENÉ, and JAUBERT DE BEAUJEU, A. Deux cas interessants de kystes hydatiques des poumons. (Two interesting cases of hydatid cysts of the lungs). *Bull. et mém. Soc. de radiol. méd. de France*, April, 1930, *18*, 176.

Two cases of hydatid cyst of the lungs (the first in a man of twenty-five and the second in a woman of twenty-four) are briefly described and the roentgenograms reproduced. The differential diagnosis as a rule encounters no difficulties.—*T. Leucutia.*

SCHULTE, G. Pneumokoniosen der Ruhrbergleute und Lungenkarzinom. (Pneumoconiosis of the Ruhr miners and lung carcinoma.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1930, *41*, 444–445.

There are three stages of pneumoconiosis; mild, moderate and severe. During the past five years 487 cases of moderate and severe pneumoconiosis were observed by the author in the Ruhr district and not one of these cases was associated with carcinoma of the lung. During the same period 27 cases of primary carcinomas of the lung were observed and in none of these cases was there evidence of pneumoconiosis. A check-up of all autopsies performed by Drs. Husten and Biasi revealed that in 340 cases of pneumoconiosis not one case of carcinoma was found.

This proves conclusively that dust (as a mechanical irritant) does not play a part in the etiology of lung carcinoma. The reason why in the Schneeberg district pneumoconiosis is so often associated with carcinoma of the lung (the Schneeberg lung carcinoma being considered an occupational disease) is due most probably to the presence of arsenic and radioactive substances (especially radium emanation) in the dust of those mines.—*T. Leucutia.*

VAN ALLEN, C. M., and ADAMS, W. E. The mechanism of obstructive pulmonary atelectasis. *Surg., Gynec. & Obst.*, Feb., 1930, *50*, 385–396.

Experiments on dogs under various anesthetics were performed to determine the relative effects of the following factors in the production of obstructive pulmonary atelectasis: (*a*) quiet respiration; (*b*) straining respiration; (*c*) type of substance causing bronchial obstruction; (*d*) complete bronchial obstruction; (*e*) valvular bronchial obstruction, and (*f*) presence or absence of blood supply to the obstructed lobes.

It is concluded that: (1) Straining respiration is essential to the production of obstructive pulmonary atelectasis in the normal lung. (2) Valvular obstruction produces atelectasis more rapidly than total obstruction, but there is no evidence that valvular obstruction occurs spontaneously in man. (3) Pent up bronchial air is probably lost from the lung by blood stream absorption. (4) Obstructive atelectasis develops centrifugally from the hilum outward. (5) Decreased intrapleural and intrabronchial pressures are characteristic in obstructive pulmonary atelectasis.—*G. R. Miller.*

CORYLLOS, POL. N. Postoperative pulmonary complications and bronchial obstruction. Postoperative bronchitis, atelectasis (apneumatosis) and pneumonitis, considered as phases of the same syndrome. *Surg., Gynec. & Obst.*, May, 1930, *50*, 795–827.

There is a close relationship between postoperative bronchitis, atelectasis and pneumonia. These conditions usually follow one another in the order named without clear-cut distinctive signs. They represent evolutional phases of postoperative bronchial obstruction by mucus plug.

Careful analysis of a voluminous literature plus original observations and experiments result in the rejection of the diaphragmatic and muscular theory, the bronchoconstrictor theory and the vasomotor reflex theory of the etiology of atelectasis. Bronchial obstruction is the only determining cause of the disease.

There is no absolute distinction possible between postoperative bronchitis, atelectasis and pneumonia. Clinically, pathologically and etiologically there are marked similarities. Pneumonia as well as atelectasis causes displacement toward the affected side. The greater toxicity of pneumonia is probably due to a more virulent organism.

There are no differences between postoperative pneumonia and atelectasis other than those due to the type and virulence of the organisms infecting the occluding bronchial mucus. The condition is produced by the plugging of a bronchus by mucus, which is followed by absorption of the alveolar air. The obstruction of a lung depends not only on the mucus but on

the lessened expelling force of the lung, which is commonly decreased postoperatively by narcotics, pain, posture, splinting of the thorax, paralysis of the respiratory muscles or because of general weakness. Pneumococcus type IV is found in the mucus in these cases as it is in patients' mouths preoperatively.

Once established the course of an atelectasis may be:

(1) Recovery due to disruption of the obstructing mucus by cough. Subsequent occlusion of a new bronchus accounts for the variability of the physical signs. (2) Progression to pneumonia in cases of prolonged occlusion, provided the pneumococci are of sufficient virulence. (3) Suppuration, should occlusion be prolonged in the presence of pyogenic organisms.

Treatment consists of: (*a*) Prophylaxis—oral hygiene, abstinence from too much morphine and atropine, the inhalation of oxygen and carbon dioxide, and change of position. (*b*) Established cases—carbon dioxide inhalation, change of position and bronchoscopic drainage in extreme cases.—*G. R. Miller.*

Armand-Delille, P.-F., and Leunda, J. Injection intrabronchique de lipiodol chez l'enfant au moyen d'une nouvelle technique. (Intrabronchial injection of lipiodol in children by means of a new technique.) *Presse méd.*, March 15, 1930, *38*, 378–380.

The intrabronchial injection of lipiodol may be performed by three routes: (1) the infraglottic, (2) the supraglottic, and (3) the transglottic route.

(1) The infraglottic route which consists in the insertion of a trocar into the trachea through the intercricothyroid space, is used only in adults and adolescents. In children the intercricothyroid space is not as yet developed and consequently the method is impractical. (2) The supraglottic route consists in the injection of lipiodol into the laryngeal vestibule by means of a cannula introduced under the guide of a finger. Since this method necessitates careful cooperation on the part of the patient it also cannot be used in children. (3)The transglottic method is similar to the supraglottic except that a long cannula is used which is passed through the rima glottidis. This constitutes the method of choice in children. Cannulas of varying sizes are used for different ages and the lipiodol is injected following cocaine anesthesia of the upper respiratory passages. The detailed technique is as follows: The child is held by a nurse in a sitting position as for any laryngoscopic examination. The throat is repeatedly sprayed with a 10 per cent cocaine solution, then the cannula is introduced under the guidance of the finger until it has passed the rima glottidis. At this moment 2 to 5 c.c. of a 1 per cent cocaine solution is injected for the anesthesia of the bronchi and a few minutes later 5 to 20c.c. lipiodol (at 40°C.) is injected. After placing the patient in the necessary position (for the side or part of the lung to be examined) the rest of the lipiodol (10 to 30 c.c.) is introduced. Five to ten minutes later the injected bronchial tree is studied under the roentgenoscope and then films are taken.

The method is indicated in bronchial dilatation, in chronic recurrent bronchitis, in cough of long duration following pertussis and bronchopneumonia, in tracheal deviation, in tuberculous lesions and for the differential diagnosis of certain interlobar pleurisies.—*T. Leucutia.*

Lepennetier, F., and Altman, J. Corps étrangers bronchiques. (Foreign bodies in the bronchi.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1930, *18*, 173–174.

The authors present two unusual cases of foreign bodies within the bronchi. In the first case, that of a girl aged twenty-five, a pin was present in the right inferior lobe for a period of eight years without producing any symptoms. In the second case, that of a boy aged nineteen who suffered from infantile asthma, the foreign body, likewise a pin, was expelled within forty-eight hours as a result of an asthmatic attack. The conclusion is reached that certain intrabronchial foreign bodies are well tolerated and that in very rare instances they are expelled spontaneously.—*T. Leucutia.*

Lloyd, John J. Broncholiths. *Am. J. M. Sc.*, May, 1930, *179*, 694–699.

Broncholith is the most commonly accepted term for lung stones, though the majority of these calculi have their origin in the lung tissue outside the bronchus. Although other causes exist, tuberculosis is the disease in which broncholiths are most apt to arise. Often they are multiple.

A review of the English literature since 1900 resulted in the finding of 18 cases. West found 15 cases in 1902. Four cases reported in this article give a total of 37.

The condition may easily be overlooked in history taking unless direct questioning is resorted to. The erosion of a calculus into a bronchus may cause serious results should the stone fail to be expectorated. Two cases of tuberculosis expectorated multiple broncholiths. Two non-tuberculous cases expectorated single broncholiths and subsequently showed by roentgen examination the disappearance of shadows of calcification seen in previous films.—*G. R. Miller.*

KLASON, T. On the horizontal orthoprojection of the heart. *Acta radiol.*, Apr. 30, 1930, *11*, 57–77.

This paper is an abstract of a longer work by the author and includes four parts. The first part is a detailed anatomical description of the localization of the heart cavities in different projections. It is based chiefly on anatomical frozen sections through the thorax. In the second part the author describes his method of obtaining an orthoprojection of the heart on a horizontal plane with the patient standing. In the third part tables are given showing the normal measurements of the frontal orthodiagram and the horizontal orthoprojection of the heart in 150 healthy men and women. In the last part the author discusses the changes that take place in the shape and size of the horizontal orthoprojection on pathological changes in the size of the four heart cavities.—*Audrey G. Morgan.*

MEYER-BORSTEL, H. Über Form- und Grössenveränderungen des Herzens bei Struma. (Changes in the form and size of the heart in struma.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1930, *41*, 695–713.

The author made a roentgen examination of the heart in 76 cases of non-toxic and 80 cases of toxic goiter. In both groups a distinction was made as to whether or not the goiter pressed on the trachea. It was found that in 59 per cent of the cases with non-toxic and in 83 per cent of the cases with toxic goiter there was evidence of disturbance in the size and form of the heart. The tracheal stenosis produced by certain goiters did not produce any material change in the above percentages, indicating that the "mechanical" effect is without importance. The disturbance in size of the heart consisted mainly of a bilateral enlargement, usually more pronounced on the right side. The author, contrary to other investigators, found enlargement confined to the left half of the heart only in rare instances. The silhouette of a thyroid heart on the roentgenogram has a rather typical appearance. Due to an enlargement of the right half of the heart there is a prominence of the right lower border of the silhouette. The pulmonary arch and the left median arc are accentuated. The left border of the silhouette is steeper than the normal. Thus the configuration as a whole resembles that of a typical mitral lesion. A differentiation, however, is easily accomplished by roentgenoscopic examination, the pulsation and rhythm of the heart being entirely different in the two conditions. In cases of uncertain clinical diagnosis this could be used for the confirmation of hyperthyroidism.

The author is of the opinion that the cardiac enlargement in hyperthyroidism is of a permanent nature. In many instances it continues to progress following operative intervention (thyroidectomy).

The article is profusely illustrated with roentgenograms and schematic drawings.—*T. Leucutia.*

ARKUSSKY, J. Zur röntgenologischen Charakteristik der Funktionsfähigkeit des Herzens. (The roentgen characteristics of the functional capacity of the heart.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1930, *41*, 714–731.

The clinical methods of examination (percussion, auscultation, response to forced exercise and water test of Böttner), although of great value in the diagnosis of static changes of the heart, are entirely useless for the determination of the functional capacity. The roentgen examination permits a more accurate evaluation. On the basis of numerous examples (the cases being described more or less in detail and illustrated with roentgenograms and drawings) the author discusses the most characteristic signs of (1) hypertrophy; (2) myogen dilatation, and (3) tonus of the heart. It is advised that the orthodiagraphic measurements be carried out in the posteroanterior and chiefly in the second oblique position, the rotation of the patient amounting 60 to 70°.

In discussing the tonus of the heart muscle, the importance of a detailed study of the right ventricle is emphasized. In many instances the equilibrium of the whole hemodynamic system is dependent on the functional capacity of this

portion of the heart. Of course other factors such as the changes of the angle of inclination during expiration and inspiration as well as the form of the entire heart and its different segments, the character of the pulsation, the amplitude, blood pressure, and the condition of the nervous system, must also be taken into consideration. The tonus of the heart muscle is the resultant of several factors which must all be accurately known.—*T. Leucutia.*

Imperatori, Charles J. Cardiospasm. *Arch. Otolaryngol.*, Feb., 1930, *11*, 178–187.

Jackson has stated that a large proportion of cases diagnosed as cardiospasm are not spasmodic. The condition has been considered as a neurosis. Some authors think that it is an endocrine imbalance. Mosher has demonstrated a pathologic change in the liver tunnel in some cases. In others, cicatrices and adhesions were the cause. Pathologic conditions in the left lower lobe have been cited as a cause. Jackson has demonstrated a physiological kinking of the abdominal esophagus and a diaphragmatic pinchcock. Cardiospasm may represent repressed desires. Grieg thought 3 factors were concerned. (1) Esophageal opening in the diaphragm is never modified by movements of the diaphragm. The esophagus has in common with the lungs a parasympathetic nerve supply from the bulbar portion in addition to the sympathetic supply. (2) Physiologically, the esophagus maintains a certain degree of tonus. (3) Pathologically, congenital or primary nerve fault may prevent the esophagus from relaxing.

Peristalsis of the esophagus follows deglutition. It is a reflex mechanism with one sensory and multiple motor impulses. Secondary peristalsis is controlled by multiple reflexes and these reflexes depend upon a bolus, etc., and the integrity of the esophagus.

Rolleston thought cardiospasm was due to a neuromuscular reflex. Mosher has never recognized any case in which spasm was present. Alvarez thought that Auerbach's plexus exercised a control over the muscle. The author believes that the staining technique of the tissues is so poor that one cannot demonstrate changes that may be present. Cannon and a number of authors think that the cardia relaxes as soon as the patient swallows. For instance, cutting the vagi in the neck will cause spasm of the cardia. Against this view is the marked relaxation that occurs following the spasm. Cardiospasm may be present for thirty or more years. Reflexes probably could not be maintained so long. One or two dilatations cure 60 to 80 per cent of patients. It appears that the contraction is in the rough submucous coat and not in the diaphragmatic fibers surrounding the esophagus, as the spincter is generally situated below this point as determined by roentgenoscopy. Schlippe has demonstrated contraction of the diaphragm during vomiting yet food leaves the stomach. There is a plexus of nerves situated between the circular and longitudinal muscle by which a local nerve mechanism is maintained.

Symptomatology. A sense of discomfort, eructation of gas and sour food, shortness of breath after meals, hiccough, cough, epigastric pain, etc., are some of the symptoms experienced.

Diagnosis. The diagnosis is made by the roentgenologist. There is a diffuse dilatation of the esophagus, with a stenosis at the diaphragm, the shadow narrowing to a trickle through the abdominal esophagus. The appearance by the esophagoscope is a widely dilated esophagus with a grayish-white pasty mucosa looking like a furred tongue. At the bottom of the sac is a white floor of wrinkled esophageal wall through which the diaphragm can be felt. There is normal resistance to the esophagoscope at the cardiac end. There is no loss of continuity of the coat.

Treatment. The author discusses and illustrates the method of treatment which is done under roentgenoscopic guidance.—*E. P. Pendergrass.*

ABDOMEN

Beilin, D. S. When has visceroptosis clinical significance? *Radiology*, August, 1930, *15*, 223–226.

To this question the author answers as follows: When symptoms arise as a result of perverted function in a visceroptotic individual in whom organic disease has been excluded, then, and then only, has visceroptosis clinical significance. The cardinal diagnostic fluoroscopic sign of gastroptosis and coloptosis is that the symptoms are usually relieved when the stomach or colon is elevated manually, and almost immediately entirely relieved when the patient is placed in the Trendelenburg position. The anatomical position of the stomach and colon in the so-called normal individual is dependent upon the habitus as well as the inherited constitutional frame of the individual.

Their low position is of no significance except when it interferes with physiological function. The responsibility for the diagnosis of clinical gastroptosis and coloptosis is almost entirely dependent upon the clinical roentgenologist as a careful objective exclusion diagnosis of organic disease of the gastrointestinal tract must be made.—*J. D. Camp.*

WINKELSTEIN, ASHER. Some clinical features of air swallowing. *J. Am. M. Ass.*, May 10, 1930, *94*, 1480–1483.

Air swallowing is frequently a cause of symptoms. A number of articles on this subject are found in the German and French literature, but very little has been written in this country or in England. Hoffman, in 1902, before the days when roentgen studies were being made, did an excellent piece of work. Since that time Reider and others have described the condition of air swallowing. Reider calls the condition "gastric pneumatosis."

Air swallowing occurs normally and may be allied as a symptom in a number of organic diseases. Eructatio nervosa, or functional nervous belching, occurs in neurotic individuals as a purposeful exaggeration of the normal. When belching is associated with organic gastrointestinal, gall-bladder, liver and cardiovascular disease, it is called eructatio symptomatica.

In another group, gastric pneumatosis, air is trapped in the stomach and causes gastric, respiratory and cardiac symptoms. In gastrointestinal pneumatosis, the air passes from the stomach into the small and large intestine, giving, usually, intestinal symptoms. The author presents 3 cases representing a new clinical syndrome.

The cause of retention of air in the stomach is discussed and the treatment for the affection is briefly considered.—*E. P. Pendergrass.*

RIGLER, LEO G. Roentgenologic observations on benign tumors of the stomach. *Am. J. Surg.*, Jan., 1930, *8*, 144–150.

Eusterman and Senty estimated that only 1.3 per cent of all tumors of the stomach coming to operation were benign. Recent literature suggests that these are more common than previously thought. Eliason and Wright have reported 50 cases, while Pendergrass reported 30 cases of the pedunculated type alone, and the author has seen 11 in the last two years. Hillstrom found 5 per cent of tumors of the stomach, removed at operation and at postmortem examinations, to be benign. Statistics may be unreliable because these tumors may be missed at operation if the stomach is not opened and may undergo malignant degeneration if not removed.

Benign gastric tumors may produce severe symptoms and they may be the origin of the polypoid type of carcinoma. Surgical removal is comparatively simple with excellent end-results. Etiologically, there is a close relationship between chronic gastritis and hypertrophied gastric mucosa. Pathologically, they may be classified as multiple polyposis, angioma, myoma fibromyoma, cysts, hypertrophied mucosa, and several other rare types. From the clinical and roentgenological standpoint they are classified as polypi, ball-valve tumors, angiomata, myomata, and multiple polyposis. The ball-valve type are pedunculated and often prolapse through the pylorus, causing obstruction. Symptomatology depends on size, multiplicity, location, and character of the tumor. The symptoms are due to hemorrhage, obstruction, ulceration, and disturbance of gastric function. The physical signs are essentially negative. The laboratory findings frequently show achylia gastrica, especially in generalized polyposis. A secondary anemia, simulating a primary anemia, may be present. Blood in the gastric contents has been found. The differential diagnosis must be made from carcinoma, ulcer, gastritis, pernicious anemia, and functional dyspepsia. The roentgen examination by barium meal is the best method of establishing a diagnosis.

The roentgen signs are: (1) a central defect which is round or oval, smooth in contour and sharply outlined; (2) peristalsis passes through the gastric walls of the defect; (3) the gastric walls are flexible in the region of the tumor; (4) the defect is frequently movable; (5) a pedicle may be demonstrated; (6) the defect may be in the duodenum in prolapsed pedunculated tumors; (7) the lumen of the stomach is not decreased in size; (8) there may be pyloric obstruction; (9) there are multiple defects in multiple polyposis; (10) in hypertrophied gastric mucosa, the defects may appear as ridges of exaggerated type; (11) the rugae above and around the tumor may be unaffected. Overfilling the stomach with barium must be avoided in looking for these tumors. Manipulation of the stomach is necessary, especially to produce pressure. Examinations must be

made in both the upright and prone postures, and observation of peristalsis and flexibility of the stomach is essential. Roentgenologically, benign tumors must be differentiated from retained food particles, foreign bodies, gastritis, and carcinoma. Benign tumors may be present associated with other pathological conditions.

The author reports 19 cases of roentgenologically diagnosed benign lesions of the stomach. These include 13 cases of benign tumors, 2 cases of benign polypi with malignant degeneration, and 4 cases of hypertrophic gastritis verging on polyposis. He has included as illustrations, roentgenograms which are typical of the various types of lesions described.—*Vincent Johnson.*

Einhorn, Moses. Anatomical consideration of the ulcer bearing area (lesser curvature of the stomach, pylorus and first part of the duodenum). *Surg., Gynec., & Obst.*, Feb., 1930, *50*, 416–425.

The pylorus and the first part of the duodenum show anatomical peculiarities which contrast these areas with the rest of the stomach and duodenum: (1) The pyloric wall is stronger and thicker than that of the fundus. (2) The pyloric submucosa is firmer and more adherent to the mucosa. (3) The mucosa is smoother, thicker and more adherent. (4) Pyloric rugae are parallel to the long axis. Those of the cardiac position are stellate. (5) The pylorus has only one type of gland, the fundus has two. (6) The pyloric muscles are heavier because activity is required here, whereas the fundus acts merely as a reservoir. (8) The muscles of the first part of the duodenum are bulkier than in the other parts. Sphincteric rings and mucosal folds exist here only. Brunner's glands are most numerous here. (9) The first part of the duodenum is under greater tension than the remainder. Its musoca is often damaged by the acid food.—*G. R. Miller.*

Camp, John D. Further observations on the direct roentgenologic signs of gastrojejunal and jejunal ulcer. *Radiology*, August, 1930, *15*, 274–279.

The direct roentgen signs which, according to the author, permit a positive diagnosis of gastrojejunal or jejunal ulceration are: (1) the presence of an ulcer niche; (2) persistent deformity of the stomach, stoma or jejunum; (3) the presence of a gastrojejunocolic fistula, and (4) closure of the stoma. These conditions are best shown during the fluoroscopic examination with the patient upright. The stomach should be empty and the examination should begin after only a swallow or two of the opaque meal. It is the author's impression that a niche will be seen in about 60 per cent of the cases. The majority are found in the jejunum, nearly always in the efferent loop and sometimes as far as 15 cm. from the stoma. It must be distinguished from flecks of barium caught in the gastric rugae or jejunal folds. Deformity of the stomach, stoma or jejunum produced by the associated inflammatory reaction is the most common change accompanying gastrojejunal or jejunal ulcer. It appears as a puckering about the stoma or narrowing of the jejunum. Frequently the deformed stoma has a funnel-like appearance. In the absence of a malignant lesion, a gastrojejunocolic fistula is evidence of preceding jejunal or gastrojejunal ulceration, whether additional signs are present or not.—*Author's abstract.*

Matz, Philip B. A study of intestinal tuberculosis among ex-service men. *Am. J. M. Sc.*, April, 1930, *179*, 532–546.

The records of the United States Veterans' Bureau show the following facts concerning intestinal tuberculosis: The vague clinical signs and symptoms of the disease make its exact incidence doubtful, but its incidence in 200 autopsies of patients dying from pulmonary tuberculosis was 60.5 per cent.

The largest number of the 849 patients with intestinal tuberculosis were treated for less than one year. The next largest number were treated for from one to two years.

Of the cases, 93.95 per cent had far advanced pulmonary tuberculosis (American Sanatorium Association Classification); 82.4 per cent had cavities. Most of the lesions were exudative or fibro-exudative. The time between the diagnosis of the pulmonary and the intestinal involvement varied considerably. Usually it was from one to three years. The time between the diagnosis of pulmonary tuberculosis and the onset of the first symptoms presumably due to intestinal involvement was usually from one to six months. A smaller group showed symptoms in from seven to twelve months. The most frequent symptoms were abdominal pain, loss of weight, gas formation,

loss of appetite, post-prandial discomfort, diarrhea, emaciation, dyspepsia, alternating constipation and diarrhea.

The roentgen diagnosis after Brown and Sampson coupled with a clinical diagnosis proved most accurate in detecting the disease.

Treatment usually included rest, diet, heliotherapy (both natural and artificial), and medicinal therapy including calcium chloride. Of 849 patients 21 per cent were improved and 2 per cent were cured.

Most frequently the cecum, terminal ileum and ascending colon were involved; 97.5 per cent of cases showed pulmonary involvement. Perforation occurred in 17 and obstruction in 20 cases out of a total of 490 cases. Laboratory findings are of little assistance in early diagnosis. Death usually is due to a spread of pulmonary or intestinal disease. The autopsy figures show a higher proportion of healed ulcers, either alone or in conjunction with active ulcers, in those cases given heliotherapy.

It is concluded that ultraviolet radiation has a beneficial effect upon intestinal tuberculosis, but it is questionable whether or not it may lead to a cure.—*G. R. Miller.*

BRUNN, HAROLD, and RHODES, GEORGE K. Acute hematogenous (metastatic) perinephric abscesses. *J. Am. M. Ass.*, Mar. 1, 1930, *94*, 618–622.

Attention is called to the close similarity between acute hematogenous peinephric abscess and acute hematogenous osteomyelitis. Both follow pyogenic skin infections, such as boils, carbuncles, and eczema, and are almost invariably due to the *Staphylococcus aureus* and *albus*. Such infections may be of slight moment and may antedate the bone or kidney lesion by several weeks or months. In children, the metastatic lesion occurs in the bone marrow, while in the adult it is found in the perirenal fat. In both these regions, end arteries are to be found. These offer excellent lodgment for septic emboli. That perinephric abscess seldom occurs in children is due to the fact that the perinephric fat in childhood is developed very poorly, if at all. A diagram is presented showing the arterial supply to the region of the fatty capsule of the kidney.

Because of the greater number of end arteries in the renal cortex, lodgment of infected emboli with resulting cortical abscess is more common than perinephritic abscess. The two conditions, however, present quite similar clinical pictures. A cortical abscess may rupture into the fatty capsule and give rise to a secondary perinephric abscess. While this is the usual sequence, attention is called to the fact that a perinephric abscess may result from a cortical abscess by way of the lymphatics, since there is a free intercommunication of lymphatics through the fibrous capsule of the kidney.

The authors believe that the reason the staphylococcus is found more frequently in perinephric abscess than either the colon bacillus or the streptococcus is the fact that the staphylococcus tends to agglutinate and form clumps much more readily than the other two, and can therefore much more easily block an end artery. In addition, phagocytosis plays a large part in staphylococcic infections and thus living bacteria may at times be delivered to remote parts of the body.

Attention is called to the infrequency with which the diagnosis of perinephric abscess is made and how frequently the condition is given some other diagnosis. Thirty consecutive cases studied were divided into three groups: (1) those cases with an insidious onset presenting no signs referable to the kidneys and extremely difficult to diagnose. These frequently receive a diagnosis of influenza, typhoid, endocarditis, or tuberculosis; (2) those cases, also of insidious onset, but with more general body soreness and only moderate symptoms and discomfort referable to the kidney region, and (3) a group, more acute in onset, with symptoms indicative of renal pathology. Pain often referred to hip or leg of the affected side. Many wrongly diagnosed as presenting orthopedic conditions.

The final pathologic picture of an overlooked diagnosis in any group is that of a large subcutaneous abscess pointing in the flank.

In the diagnosis, roentgen examination gives the first positive confirmatory evidence of perinephric abscess. There are three roentgen signs indicative of this condition:

1. A fluoroscopic examination may show a delayed excursion of the diaphragm which is usually indicative of subphrenic disease.

2. A most constant sign in roentgen films, taken of both kidney regions shows an obliteration of the lateral border of the psoas muscle and an indefinite kidney shadow on the affected side. Repeated examination at intervals of a day or so will reveal a gradual obliteration of the psoas shadow. The cause of this oblitera-

tion is attributed to edema of the perirenal fat and to blocking of the lymphatics within the psoas muscle itself with lymph edema. An illustration is presented showing the intimate relationship between the lymphatics of the kidney and the psoas muscle.

3. A third sign consists of scoliosis of the lumbar vertebrae with its convexity away from the affected side. This sign, while emphasized by some observers, has been of less value to the authors.

The authors believe that the roentgen examination is of greater value in the diagnosis of perinephric abscess than any other diagnostic procedure. Of the three roentgen signs given, they have found the second of greatest value.—*Karl Kornblum.*

Kaufmann, Robert, and Mme. Kaufmann. Sur le radiodiagnostic lipiodolé des lésions des voies biliaires après fistule. (On the lipiodol roentgen diagnosis of lesions of the biliary tract in fistulae.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1930, *18*, 168–169.

Several authors, as is known, advocate the use of lipiodol for diagnostic purposes in fistulae of the biliary tract. In recalling the experiments of Claude Bernard, who was able to produce a hemorrhagic pancreatitis with death after injection of the Wirsung canal with fatty substances, the author experimentally studied the effect produced by the presence of lipiodol within Wirsung's canal. He injected, under chloralose anesthesia, 2 to 3 c.c. lipiodol directly into the Wirsung canal, in a dog of 8500 gm. weight, and found that death resulted within twenty-four hours. At the necropsy there were all the signs of a hemorrhagic pancreatitis.

The conclusion is drawn that lipiodol, during the injection of fistulae of the biliary tract, may enter the Wirsung canal and may produce serious complications. This is especially true when the pancreatic juice is activated either by a leucocytosis of the infected biliary tract (the leucocytes secreting a ferment capable of activating the pancreatic juice) or by the lipiodol which has entered the intestine (this again activating the pancreatic juice).—*T. Leucutia.*

Murphy, George T., and Higgins, George M. The emptying of the gallbladder following restoration from acute experimental cholecystitis. *Arch. Surg.*, May, 1930, *20*, 756–761.

The authors present experimental data which indicate that the contractility of the gallbladder is interfered with during disease, and that contractility is restored following the disappearance of the inflammation. They show the rapidity with which the acutely inflamed gallbladder may be restored to a functionally normal condition.

Acutely inflamed gall-bladders do not empty after the fatty meal. The authors believe that the disturbance is in the wall of the gall-bladder and not due to extraneous physiologic factors. The solution (ensol) used by the authors to produce the acute inflammation seems to be specific for the gall-bladder. After the gallbladder has returned to normal, peristalsis goes on, the flow of bile remains undisturbed and there is no reason to believe that the sphincteric mechanism at the duodenal end of the common bile duct is under unusual tonus, inhibiting the flow of bile from the gall-bladder.—*E. P. Pendergrass.*

GYNECOLOGY AND OBSTETRICS

Grier, G. W. The value of a lateral view in the diagnosis of pregnancy. *Radiology*. June, 1930, *14*, 571–575.

For the roentgen diagnosis of early pregnancy and multiple pregnancy, the author considers the lateral view to be decidedly more reliable than the anteroposterior. When a pregnant woman lies on her side the uterus occupies the anterior part of the abdomen and the total dimension of the tissue to be penetrated by the rays is considerably less than when she lies on her back, and a clearer image of the fetus is obtained. In the later months of pregnancy, after the fetal head has descended into the pelvis, the anteroposterior view is preferable.—*J. D. Camp.*

Jarcho, Julius. Roentgenographic examination of the female pelvic organs. *Am. J. Surg.*, March, 1930, *8*, 630–637.

Roentgen examination of the female pelvic organs is an established diagnostic aid. Insufflation of the peritoneal cavity has been reported by Stein and Stewart, Rubin, Peterson and Sage. Injection of opaque media into the uterus and tubes has been accomplished successfully by Stein and Arens. Forsdike, Haselhorst and Rubin have employed both tubal insufflation and opaque medium injection.

Pneumoperitoneum and iodized oil injection have been combined in one operation for which

the author has devised an instrument termed a "pressometer." The injection is made entirely through the uterus except in cases with occluded tubes, bloody or purulent discharge or suspected carcinoma of the fundus. In these a transabdominal insufflation is done while the uterus is outlined with oil. In either method from 800 to 1500 c.c. of gas and from 3 to 15 c.c. of oil are injected. Oxygen is less rapidly absorbed than CO_2 and may be used by the beginner. CO_2 is more comfortable for the patient. The Peterson partial knee-chest posture is used.

Accurate demonstrations of pelvic conditions are reported.—*G. R. Miller.*

GENITOURINARY SYSTEM

THOMPSON, GERSHOM J., and BUMPUS, HERMON C. JR. Ureteral kinks; how they occur at the order "take a deep breath and hold it." *J. Am. M. Ass.*, Mar. 15, 1930, *94*, 771–772.

The authors call attention to the possibility of producing a kink in the ureter during pyelography when the roentgenogram is made during deep inspiration. They believe that this is the possible explanation for the fact that in many patients consulting them, on whom a previous diagnosis of ureteral kink had been made, they were unable to demonstrate such kinks. They present 3 cases with roentgenograms showing a ureteral kink when the exposure was made during full inspiration, and an absence of the kink when exposed during full expiration.—*Karl Kornblum.*

MARTIUS, H. Ueber weibliche Genitalaktinomykose. (Female genital actinomycosis.) *München. med. Wchnschr.*, March 7, 1930, *77*, 392–394.

A case of actinomycosis of the pelvic organs was treated successfully by application of fractional doses of deep roentgen therapy (0.5 mm. Cu plus 3 mm. Al, 200 kv.). The case is described in detail.—*T. Leucutia.*

NERVOUS SYSTEM

DAVIS, LOYAL, HAVEN A., and STONE, THEODORE T. The effect of injections of iodized oil in the spinal subarachnoid space. *J. Am. M. Ass.*, Mar. 15, 1930, *94*, 772–777.

In an extensive review of the literature, the authors detail the uses and abuses of injections of iodized oil. After searching the literature the authors were unable to find much evidence indicating possible dangers for the use of the opaque oils.

They report 31 cases in which it was possible to localize the lesion in the spinal cord in 29 cases without the aid of the iodized oil. They believe that it is unnecessary to inject oil in the vast majority of instances.

In 10 animals injected with iodized oil intracisternally, definite evidences of leptomeningeal reaction, fat encystment and degenerative changes in the gray matter were found. One dog died three days following the injection. They conclude that the injection of iodized oil into the subarachnoid space is to be regarded as a dangerous procedure.—*E. P. Pendergrass.*

SKELETAL SYSTEM

WAGNER, AAGE. Isolated aseptic necrosis in the epiphysis of the first metatarsal bone. *Acta radiol.*, Apr. 30, 1930, *11*, 80–87.

After reviewing the literature on the subject of the so-called aseptic epiphyseal necroses the author describes a similar but not identical affection in a girl six years of age. There was a slight but unmistakable swelling of the left foot over the joint between the tarsus and the first metatarsal bone. It was quite firm, there was no edema or superficial veins but the skin was somewhat red. The joint was slightly tender on pressure while that of the right foot was not. There was a possible history of trauma about a year before. There was no atrophy of the foot or the muscles of the leg. The muscle tone was alike on both sides. The arches of both feet were rather low but imprints showed that the patient was not flatfooted. As the ligaments were very much relaxed it was thought that the case might be one of beginning pes planus.

Roentgen examination showed the epiphysis of the proximal end of the first metatarsal bone of the left foot considerably broader from side to side than the corresponding one in the right foot, and shorter from end to end. The bone was solid except in two places where there were slight rarefactions. The demarcation toward the tibial side was not sharp but rather woolly. The interarticular space was about a millimeter wider than the one on the right foot. The lateral view of the right foot showed a distinct double outline of the epiphysis while in the left foot this double contour had almost

entirely disappeared and there was only a thin compact shell. None of the other bones of the foot were abnormal. The patient was examined two, four and six months later and the roentgen pictures were just the same. So was the swelling of the left foot; but the subjective symptoms had disappeared after the patient had been given arch supporters in her shoes and had been cautioned to avoid tiring her feet.

There is no doubt that aseptic necroses of the epiphysis may be due to different causes. The author is inclined to think that trauma was the cause in his case. He does not think the fall a year before, which did not cause any pain, brought about the disease. But in the course of the development of the patient's incipient flat-foot particularly strong pressure may have developed on the medial bones of the metatarsus and this may have contributed to the causation of the disease.—*Audrey G. Morgan.*

Jansson, Gösta. Osteochondritis dissecans (König) vom Röntgenologischen Gesichtspunkt aus betrachtet. (Osteochondritis dissecans (König) considered from the roentgenologic point of view.) *Acta radiol.*, Apr. 30, 1930, *11*, 33–56.

A number of cases are described and the author reviews Axhausen's theories in regard to the epiphyseal necroses, which include osteochondritis dissecans. Axhausen says that this disease, as well as Perthes', Kienböck's and Köhler's diseases, is caused by aseptic necrosis resulting from embolism. The differences in the roentgen picture in these diseases are caused only by differences in the secondary changes in the necrotic bones, which are to a certain extent caused by differences in the strain or weight which the joints have to support.

The author has made comparative roentgen studies of sequestra removed surgically and the corresponding changes in the joint surfaces in cases of osteochondritis dissecans and of the so-called traumatic sequestra. His examinations have shown that the sequestra in cases of osteochondritis dissecans have a different roentgen structure from other forms of sequestra, and that the roentgen changes in the condyle of the femur are specific for osteochondritis dissecans. So the roentgen findings seem to justify considering osteochondritis dissecans as having a different etiology from free joint bodies.—*Audrey G. Morgan.*

Baumann, Ernst. Ueber schienbare horizontale Halbierung von Wirbelkörpern im Röntgenbilde. (On simulated horizontal division of vertebral bodies in the roentgenogram.) *Schweizer. med. Wchnschr.*, 1930, *60*, 267.

The "horizontal division" of vertebral bodies has been observed during adolescence. The author relates briefly the history of a man, aged twenty-six, who presented this picture in five vertebrae, roentgenographically. The clinical syptom was vague back pain occurring particularly after strenuous exercise. The case had been diagnosed before as suspicious of tuberculous spondylitis. The horizontal division of vertebral bodies is, in all probability, an anomaly without pathological significance. It is caused by paired vein canals in the bone. A roentgenogram of the lateral spine is appended.—*E. A. Pohle.*

Schoenthal, Ludwig, and Burpee, Claude. Renal rickets. *Am. J. Dis. Child.*, March, 1930, *39*, 517–528.

In recent years, considerable attention has been paid to a peculiar combination of chronic renal disease and deformity of the bones, known as "renal infantilism," "renal dwarfism" or "renal rickets." Schoenthal and Burpee state that all authors have agreed that renal insufficiency is the cause of the condition. The renal insufficiency leads to an acidosis which is supposed to cause a mobilization of calcium from the bone, resulting in decalcification. They distinguish two types of renal rickets: one due to congenital malformation of the kidney or urinary tract; another due to a chronic renal insufficiency of the character of an interstitial nephritis becoming manifest later in childhood.

A case of the first type is reported in great detail. Metabolic studies on this case, a child of eight years of age, showed a negative total base balance, a negative calcium balance and a negative phosphate balance during certain periods. The blood changes were a moderately low total base, low bicarbonate, low protein, low calcium, high phosphate and high non-protein nitrogen; both calculated and observed osmotic concentrations exceeded the normal. Chronic acidosis was present over a long time.

The patient showed typical rachitic bone deformities, such as bossing of the parietal and occipital bones, rachitic rosary, pigeon chest,

Harrison's groove and genu valga. On his second admission roentgen examination showed rachitic changes of the bones and also rudimentary sinuses.

Disodium phosphate administered to the patient was poorly absorbed and slowly excreted and resulted in a lowering of the blood calcium with but a slight increase in blood phosphate. The effects were similar to those observed in genuine rickets. Sodium bicarbonate, administered by mouth, led to a positive base balance, although the calcium balance remained negative. The loss of the calcium was chiefly by way of the bowel. The effect on the blood was an increase in phosphate, a decrease in calcium and an increase in the bicarbonate and total base.

Calcium acetate, when administered by mouth, led to a decrease in blood phosphate and a slight increase in blood calcium. There was no appreciable effect on the bicarbonate or total base.

The usual methods of treatment of rickets, such as the administration of vitamin D were ineffective in this case of renal rickets. Replacement of the depleted base, calcium and phosphate, is a logical method of treatment, although the effects are but temporary unless the treatment is continuous. This may be accomplished by the administration of an alkaline ash diet, together with calcium acetate. —*R. S. Bromer.*

v. ALBERTINI, A. Bemerkungen zur sarkomatösen Entartung bei der Ostitis deformans. (Remarks on sarcomatous degeneration of osteitis deformans.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1930, *41*, 443–444.

In a recent article Wissing published 2 cases of osteodystrophia fibrosa which later transformed into sarcoma and from this he concluded that osteodystrophia fibrosa represents a presarcomatous stage. The author published a similar case in 1928 in *Virchow's Arch. f. path. Anat.*, *268*, p. 259, but cannot agree with the conclusions of Wissing. It is more probable that osteodystrophia fibrosa is only a presarcomatous intermediary stage which under certain conditions may undergo malignant degeneration and thus transform into sarcoma.—*T. Leucutia.*

STONE, ROBERT S. Echinococcic involvement of bone. *Radiology*, June, 1930, *14*, 557–561.

Echinococcus cysts in man occur rarely in the United States and Canada, and the bones are involved in less than 2 per cent of the cases. The author reports an instance in which the cysts were situated in the ilium and sacrum. Starting as a small cyst, echinococcus involvement of bone develops into a multilocular cyst with many small ones in the immediate vicinity. There is no sequestration, no atrophy and no increased calcification. Any bone may be affected, but the pelvis, femur, humerus and tibia are the most common sites.

In the same issue of *Radiology* (p. 562) Hsieh reports a case observed at Peiping, China, in which the pelvic bones and the head and neck of the right femur were involved.—*J. D. Camp.*

D'ISTRIA, A. Usure vertebrali da aneurisma. (Erosion of the vertebrae from aneurysm.) *Radiol. med.*, Jan., 1930, *17*, 1–15.

The clinical diagnosis of aneurysm of the aorta is quite difficult and may be supplemented by roentgen examination which shows erosion of the vertebrae. Recently Brailsford described a case in which the diagnosis was not made for two years, in spite of repeated roentgen examinations, but was finally made from a lateral roentgenogram and confirmed by autopsy.

The author describes 5 cases. In 3 of them the patients were syphilitic, in the fourth the patient denied syphilis but the Wassermann was positive, and nothing is said about venereal infection in the fifth. The lateral views gave a more definite picture of aneurysm than those in the anteroposterior position. There was a distinct excavation in the spinal column at the site of the aneurysm. The intervertebral discs were perfectly preserved and in each vertebra in the affected segment the spongy central substance was more eroded than the upper and lower lamina, so that the general line of the erosion is dentate with slight projections at each intervertebral disc; the greatest erosion is not uniform in all parts of the vertebra at the site of greatest pressure by the aneurysm. There is a double outline of the excavation in the roentgen picture in advanced cases, one line being at the boundary between the bone and soft parts and the other at the boundary between the partly eroded and the normal bone.

The right or left oblique projection may give details not given in the lateral picture if the erosion is asymmetrical.

The question of the cause of this erosion in aneurysm has always aroused a great deal of discussion. Morgagni and Verbrugge held that the blood in aneurysm has a "corrosive ichor," a sort of chemical property which dissolves the bone. Hunter and Scarpa held that the aneurysm increases the absorptive capacity of the lymphocytes for bone. Laennec says that the erosion is due to the constant impact of the blood against the bone and explains the almost complete destruction of the vertebrae with the discs remaining intact as being due to different specific resistance of different tissues to the action of the impact of the blood, just as leather resists the impact of water longer than wood or other solid bodies. Huchard and Oettinger hold that the erosion of the bone is preceded by a rarefying osteitis, which is practically the same thing as Franck's theory that the erosion is the result of a slow inflammation communicated to the bone from the sac of the aneurysm. But a post-mortem roentgen study of the spinal column in one of the author's cases showed that where the vertebrae were not destroyed they were normal which he thinks argues in favor of the mechanical causation of the erosion.—*Audrey G. Morgan.*

Denier. Guérison d'un ulcère géant tuberculeux de la jambe. (Healing of a giant tuberculous ulcer of the leg.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1930, *18*, 174–175.

A tuberculous ulcer of the leg was treated by the author with roentgen irradiation of the suprarenals combined with local application of diathermy and ultraviolet rays. The roentgen therapy consisted in the administration of a first series of 1200 R, and one month later a second series of 300 R (12 cm. spark gap without filter). A perfect healing ensued which has now lasted for a period of about a year. Photographs of the lesion before and after treatment are reproduced.—*T. Leucutia.*

BLOOD AND LYMPH SYSTEM

Mandeville, F. B. Roentgen-ray findings in erythroblastic anemia. *Radiology*, July, 1930, *15*, 72–84.

Erythroblastic anemia, as described by the author, is a hemolytic anemia occurring in infancy and early childhood, characterized by enlargement of the spleen, dark colored urine containing urobilin, moderate leucocytosis, and an extremely large number of erythroblasts in the circulating blood. Its etiology is obscure and only one patient with the disease is known to have reached adult life. Roentgen manifestations in the bones have been noted as follows: (1) thickening of the medullary portion of the frontal, parietal, temporal and occipital bones; (2) thinning of the inner and outer surface of the bones of the skull vault; (3) a mottled appearance of the medullary portion of the cranium in the earlier stages, described by several authors as a spongy or porous appearance; (4) striations perpendicular to the tables of the skull in the later stages, with the diploë gradually assuming a thickness equal, at times, to as much as four times its normal width; (5) irregular trabeculations in the pelvis, vertebrae, ribs, clavicles and scapulae, the appearance of which is apparently due to new bone formation; there is evidence of slight rarefaction within the trabeculated areas, which has been described as a porous appearance, which is evidently due to localized destructive bone changes; (6) definite thinning of the cortex of the long bones, an important and rather constant finding; (7) rarefaction of the shafts of the long bones, the medulla of the long bones demonstrating increased radiability, which characteristic is well illustrated and described by some authors as a transparent medulla; (8) trabeculations of the medulla of the long bones, more marked in the metaphyses, which appear as sharp and finely pencilled trabeculae near the ends of the bones; some authors have described them as trabeculations perpendicular to the cortex, but this the author has found not to be the rule; the trabeculation may affect all of the bones of the body; (9) normal joints, no pathologic change having been noted to involve the joint surfaces or spaces; (10) no periosteal elevation, periosteal involvement not being recorded, and (11) absence of pathologic fractures. Distinction of these manifestations from those produced by certain other anemias, chloroma, syphilis and metastasis is difficult.—*J. D. Camp.*

MISCELLANEOUS

Mulder, Denis. Neue Ergebnisse der Röntgenologie, Fern- und Totalaufnahmen, etc. (New results of roentgenology, teleroentgenograms and roentgenograms of the entire

body.) *Schweiz. med. Wchnschr.*, Jan. 4, 1930, *60*, 14–18.

In a brief introduction to this article Professor Iselin of the University of Bale emphasizes the great importance of Mulder's discovery which permits the production of roentgenograms at 7 to 8 meters distance. Details of the construction of the apparatus are not given since the author is negotiating with several manufacturers concerning the purchase of the patent rights. According to his statement the new apparatus affords complete protection to the operator against secondary radiation. The tubes also tolerate high currents up to 500 ma. Several reduced prints show that roentgenograms of the whole body can be taken, for instance, on films of 1.8 to 2.0 meters. Comparative studies demonstrated the fact that the general opinion as to the proper distance for teleroentgenograms must be revised. The films taken at 2 and at 8 meters reveal an enormous difference; the advantages of the parallel radiation in case of sufficient distance between light source and object are obvious. A number of case histories are related where the new method permitted the diagnosis of pathological changes heretofore overlooked.—*E. A. Pohle.*

BOUCHACOURT, L. Quels sont les principes quo m'ont conduit à la conception et à la construction en 1919, de ma bonnette no. 4, utilisant 2 ampoules et 2 écrans placés à angle droit, mais permettant une véritable endoscopie du membre fracturé ou luxé, grâce à l'emploi d'un miroir qui redresse l'une des deux images? (What are the principles that led me to the conception and to the construction in 1919 of my bonnet No. 4 utilizing two tubes and two screens placed at right angles and permitting a true endoscopy of the fractured or subluxated extremity by the use of a mirror reflecting one of the two images?) *Bull. et mém. Soc. de radiol. méd. de France*, Feb., 1930, *18*, 69–74.

In 1919 the author constructed a bonnet for viewing the fluoroscopic reduction of fractures and subluxations in two planes. Two tubes and two screens at right angles were employed for this purpose and one of the roentgenoscopic images was reflected by means of a mirror placed at 45° so that the observer could see (in his bonnet) both images simultaneously, one above the other.

The bonnet is redescribed because of a recent tendency by several authors to use the biplane viewing and especially on account of an article by L. G. McCutchen on "The value of the biplane fluoroscopic screen in the reduction of fractures and the removal of foreign bodies energizing both tubes at the same time" (*Radiology*, Jan., 1930, *14*, 66), in order to draw attention to the fact that the principle of the method was used long before. Moreover, in the model constructed by the author (and now perfected by G. Pascalis), thanks to the mirror arrangement, the images in the two planes can be viewed by the observer simultaneously, while in all other apparatus the images have to be viewed alternatingly or by two different observers.—*T. Leucutia.*

BELOT, J. La protection intégrale (Massiot, constructeur). Nouveau modèle perfectionné (1930). (Integral protection (constructed by Massiot); new improved model, 1930.) *Bull. et mém. Soc. de radiol. méd. de France*, Feb., 1930, *18*, 61–64.

As is known, the author recently designed a roentgenoscopic unit embodying the principle of integral protection of the operator against both direct and indirect radiation.

The unit consists of a separate room reserved for the generating apparatus, a fluoroscopic room for the examining roentgenologist and his assistants and a corridor for the patient placed between the machine room and examining room.

As a result of the experience gained during the past year, new improvements have been added: the roentgenoscopic screen was provided with a selector for roentgenograms in series, the movability of the screen in the vertical direction was extended so as to be able to examine children, the flexibility of the tube and of the diaphragm system was increased, the platform for the patient was perfected, a transparent mobile hook was placed behind the patient so as to draw him nearer to the film during the taking of roentgenograms, the focus screen distance was reduced to 1 meter, 30 cm. for teleroentgenography and to 80 cm. for roentgenoscopy and provisions were made so as to be able to take simple stereograms and telestereograms.

As a result of these improvements the apparatus can be handled with ease for all types of examinations.—*T. Leucutia.*

SUBJECT INDEX TO VOLUME XXIV

(abs) = Abstract. (E) = Editorial. (B.R.) = Book Review

Abdomen, operation on, effect on mechanism of respiration (abs), 451
Abscess, acute hematogenous (metastatic) perinephric (abs), 708
subphrenic, 125; (abs), 218
Acromio-clavicular joint, tuberculosis of (abs), 95
Actinomycosis, cervicofacial, roentgen therapy (abs), 603
female genital (abs), 710
Adenomas, multiple malignant, of the kidney (abs), 330
Air swallowing, clinical features of (abs), 706
American Roentgen Ray Society, annual meeting, 194; (E), 434
commercial exhibit, 441
officers elected, 574
scientific exhibit, 438
Amniography, 363
Analytic field selector (abs), 345
Anemia, erythroblastic, roentgen findings (abs), 713
Aneurysm, erosion of vertebrae from (abs), 712
of horizontal aortic arch, 558
Angina pectoris, treatment of, by paravertebral short wave radiation, 163, 312
Angioendotheliomas about the jaws, 534
Aorta, aneurysm of horizontal arch of, 558
ascending, modification of procedure of measuring diameter of (abs), 451
coarctation of, (adult type) roentgen diagnosis, 349
pathologic, 154
Apparatus, diagnostic, check-up of time of exposure (abs), 344
roentgen, giving absolute safety against high tension currents, 573
Appendicitis, chronic, roentgen diagnosis, 631
chronic, segmental colitis an indirect sign of (abs), 591
Aqueous solutions, mechanism of chemical roentgen reactions in (abs), 345
Arteries, bronchial and pulmonary, experimental method for radiographic demonstration of (abs), 84
Artery, pulmonary, roentgen image of congenital stenosis of (abs), 583
Asthma, bronchial, roentgen therapy (abs), 472
incidence of sinusitis in children suffering from (abs), 450
Atelectasis: See Lungs, collapse
Azygos lobe: See Lungs

Bacteria, effect of cathode rays upon (abs), 348
effect of x-rays upon (abs), 347
Bacteriophage, effect of x-ray upon, and on bacterial organism (abs), 347
Banti's disease, attacks of hepatargia during roentgen treatment of (abs), 476
Basal metabolism, effect of roentgen irradiation on (abs), 346
Basedow's disease: See Goiter, exophthalmic
Beginnings (the): Egypt and Assyria. By Warren R. Dawson (B.R.), 579
Binoculars, reading of stereograms with aid of (abs), 345
Biotypy of skeleton (abs), 592
Bladder, management of new growths in (abs), 460
unusual type of lithiasis (abs), 460
Body, cavities of, campiodol in visualization of, 477
entire, new results of roentgenography of (abs), 713
Bone, chondrosarcoma of (abs), 466
diseases of, interpretation of roentgenogram in (abs), 330
echinococcic involvement (abs), 712
growing, lead line in, as roentgen sign of plumbism, 550
involvement of, in Hodgkin's disease (abs), 218; (abs), 219
lesions of, in tardive heredosyphilis, 234
metastases from cancer, analgesic effect of roentgen rays in (abs), 338
metastases, in mammary carcinoma, roentgen therapy of (abs), 334
roentgen characteristics of lesions of (abs), 94
roentgenologically demonstrable changes in Gaucher's disease, 258
small round cell sarcoma of (Ewing's sarcoma) (abs), 463
thyroid metastases in (abs), 465
Bones of leg, unusual congenital anomaly of (abs), 599
Book Reviews
Les Rayons Ultra-violets et Infra-rouges. By W. Vignal, 320
La Sensitométrie Cutanée. By J. Saidman, 320
The Effect of Roentgen Irradiation on the Interrelation between Malignant Tumors and Their Hosts. By Carl Krebs, 444
Experimental Studies on Roentgen Treatment of Malignant Tumors. By Jens Juul, 445
Die Radiumbehandlung in der Augenheilkunde. By Leo Kumer and L. Sallmann, 445
Medical and Surgical Year-Book of the Physicians Hospital of Plattsburgh, 446
Ergebnisse der medizinischen Strahlenforschung (Röntgendiagnostik, Röntgen-, Radium- und Lichttherapie). Volume IV. Edited by H. Holfelder, H. Holthusen, O. Jüngling, H. Martius and H. R. Schinz, 578

Normale Anatomie des Kopfes im Röntgenbild. By Karl Goldhamer, 578
The Beginnings; Egypt and Assyria. By Warren R. Dawson, 579
Das Ulcusproblem in Lichte moderner Röntgenforschung. By H. U. Albrecht, 694
X-Ray Crystallography. By R. W. James, 694
Radiumtherapie, Methoden und Aussichten. By F. Gudzent, 695
Ultra-Violet Radiations and Their Uses. By Robert Aitken, 695
BORDERLINE RAYS, mecapion for measurement of (abs), 111
treatment of skin diseases with (abs), 103
treatment results with, in dermatology (abs), 338
BOWMAN, WILLIAM B., an appreciation (E), 567
obituary notice (E), 567
portrait opposite page 567
BRAIN, calcifications of pia mater of, of angiomatous origin, demonstrated by roentgenography (abs), 324
demonstration of cisternae of base of, and its diagnostic utility (abs) 203
generalized pressure atrophy of, secondary to traumatic and pathologic involvement of Pacchionian bodies (abs) 324
BREAST, cancer, result of combined surgical and radiological treatment at Radiumhemmet (abs), 601
carcinoma, deep roentgen therapy, five year results, 673
carcinoma, results of roentgen therapy (abs), 341
carcinoma, roentgen treatment of metastasis to vertebrae and bones of pelvis from, 657
malignancy of, present status of roentgen therapy (abs), 104
roentgenologic study of, 113
BROMINOL-LIGHT, experiments with, on gall-bladder of dog, 634
BRONCHI, foreign bodies in (abs), 703
BRONCHIECTASIS (abs), 208
atelectatic (abs), 325
BRONCHOGRAPHY, studies on (abs), 85
BRONCHOLITHS (abs), 703
BRONCHOSINUSITIS DISEASE, a correction, 199
BROWN, RICHARD MARK, obituary notice (E), 568
BUCKY DIAPHRAGM, use of, in pulmonary roentgenograms (abs), 107
BUCKY RAYS: See Borderline rays
BURNS and cauterization of human skin, roentgen treatment (abs), 221
indirect roentgen, 310
BUSI'S ROENTGEN SIGN in ileo-ceco-colic invagination (abs), 454

CALCAREOUS SHADOWS in right hypochondrium (abs), 587
CALCIFICATION of pia mater of brain of angiomatous origin (abs), 324
of pleura (abs), 325
of vasa deferentia, case of almost total (abs), 591
partial, of articular capsule of shoulder, radiotherapy (abs), 102
CALCIFICATIONS, intervertebral (abs), 219
CALCIUM, shadows of, in region of soft tissues of neck (abs), 83
CALCULI, migrating, of ureter (abs), 591
CALDWELL LECTURE, 1930, 605
CAMPIODOL (iodized rapeseed oil) in visualization of body cavities, 477
CANCER: See also Carcinoma; Tumors, malignant, etc.
clinical evaluation of radium and roentgen therapy in advanced, with various combinations of wave lengths, 540
concerted action in fight against (E), 687
of breast, result of combined surgical and radiological treatment at Radiumhemmet (abs), 601
of cervix, résumé of work of subcommittee charged with study of radiotherapy of (abs), 603
of esophagus (abs), 324
of prostrate (abs), 461
of rectum, advantages and limitations of radiation in treatment (abs), 343
of rectum, inoperable, curietherapy with method of Neumann and Coryn (abs), 106
of skin, results of roentgen treatment (abs), 333
of uterus, chief point in struggle against (abs), 335
present status of roentgen therapy of (abs), 473
radiation treatment, 310
relative value of radium in treatment of, 180
CAPILLARY LINE in right lung field (abs), 583
CARCINOMA, buccal, radium treatment (abs), 470
cachexia, organotherapy with hipocids in (abs), 222
histochemical examinations of, before and after irradiation (abs), 336
mammary, roentgen therapy of bone metastases in (abs), 334
of breast, deep roentgen therapy, five year results, 673
of breast, results of roentgen therapy (abs), 341
of breast, roentgen treatment of metastasis to vertebrae and bones of pelvis from, 657
of cervix, complications in urinary tract due to, 47
of cervix, dosage of hard roentgen rays from distant fields in treatment (abs), 342
of cervix, investigation of relation between histological findings and results of radiation therapy (abs), 474
of cervix, results from treatment with radium and roentgen rays, 1915–1923, 54
of cervix, results obtained in treatment with radium and x-rays (abs), 343

of larynx, radiation treatment (abs), 337
of oral cavity, what is essential for successful for successful therapy (abs),471
of ovary, report of three cases treated by deep roentgen therapy, 63
of prostate, value of high voltage x-ray therapy (abs), 472
of stomach, early diagnosis (E), 563
of tongue, cured for six years by roentgen treatment alone (abs), 224
of uterus, treatment of, 412
primary, of the lung (abs), 209
rectal, radium treatment (abs), 473
roentgen, knowledge of, as occupational disease (abs), 473
roentgen studies of (abs), 223
Cardio-aortic shadow, variations of, due to obesity or emaciation (abs), 85
Cardiospasm (abs), 705
in new-born infant (abs), 453
Castration, roentgen histological study of uterine mucous membrane after (abs), 474
Cathode rays, effect of, upon certain bacteria (abs), 348
Cecum, abnormalities in position and size (abs), 217
stasis of, its clinical significance and relation to proximal colon stasis, 1
Central nervous system, effect of roentgen rays upon (abs), 340
Chest of new-born infant, roentgen appearance, 140
roentgenograms of, in nontuberculous children suspected of being tuberculous (abs), 701
Children, asthenic, motility of empty stomach in normal and malnourished (abs), 453
chest roentgenograms of nontuberculous, suspected of being tuberculous (abs), 701
intrabronchial injection of lipiodol in, by new technique (abs), 703
of rural district, percentage of latent tuberculosis and primary complexes demonstrable roentgenologically in (abs), 584
Chloroma, report of case with recovery following roentgen therapy (abs), 475
Cholecystitis, experimental production of an x-ray (abs), 107
Cholecystograms, unusual, and their interpretation, 516
Cholecystography, function of the gall-bladder and (abs), 586
in left lateroanterior position, 313
liver function and (abs), 587
study of 506 cases (abs), 327
with urologic examination for diagnosis (abs), 327
Cholesterin, destruction of, by roentgen rays in vitro (abs), 347
Chondrosarcoma of bone (abs), 466
Cin-ex camera, 575
Cisternae of base of brain, demonstration of, and its diagnostic utility (abs), 203
Coarctation of aorta (adult type), roentgen diagnosis, 349
Coccidioidal granuloma (abs), 101; (abs), 467
Colitis, segmental, indirect sign of chronic appendicitis (abs), 591
Colon, abnormalities in position and size (abs), 217
diverticula of (abs), 454
factors of error in roentgen diagnosis of diseases of (abs), 217
multiple diverticula of (abs), 328
multiple polyposis of (abs), 454
right diaphragmatic hernia of (abs), 588
right, roentgen picture of, in rapid emptying of stomach (abs), 454
studies on, cecal stasis; its clinical significance and relation to proximal colon stasis, 1
ulcer of, subphrenic pyopneumothorax from perforation of (abs), 588
Columbia paste, construction of apparatus of, for superficial radium therapy (abs), 101
Coolidge, W. D., portrait opposite page 189
Cor bovinum, differential diagnosis (abs), 584
Cranio-vertebral region, anomalies of (abs), 333
Cranium, fractures of, rôle of osseous structures in (abs), 450
roentgen diagnosis of space-narrowing processes in (abs), 582
Crouzon's disease, roentgen study of case of (abs), 582
Cystography in infancy and childhood (abs), 457

Dental caries as contributing factor in maxillary sinusitis (abs), 698
Dermatology, standardization of roentgen procedures in (abs), 103
Developmental disturbance, multiple, unusual form of the fingers, in adolescence (abs),96
Dextrocardia, congenital mirror picture, with situs transversus, patent ductus arteriosus and subacute bacterial inflammation (abs), 467
Diaphragm, eventration of (abs), 586
paralysis of left side of (abs), 214
right-sided relaxation of, 430
traumatic rupture of, 679
Digestive tract: See Gastrointestinal tract
Diverticula, cardiaproximal, of stomach, symptomatology and diagnosis (abs), 586
congenital, of duodenum (abs), 328
multiple, of the colon (abs), 328
of colon and appendices epiploica (abs), 454
of esophagus (abs), 215
pseudo, of antrum of stomach (abs), 589
Diverticulum, anterior, of esophagus (abs), 324
duodenal-jejunal, recognition of (abs), 88
in free duodenum (abs), 589
of duodenum perforated into pancreas, 684
of esophagus which developed rapidly (abs), 450
Dose, measurement of, and filtration of roentgen rays in skin diseases (abs), 468

DOSIMETER, construction and calibration of standard, 72
DUODENUM, chronic stasis of, observations in 24 cases (abs), 88
congenital diverticula of (abs), 328
diverticulum of, perforated into pancreas, 684
free, diverticulum in (abs), 589
papilloma of, roentgen diagnosis, 554
ulcer, roentgen examination of perforation of (abs), 589
ulcer, usefulness of roentgen signs in (abs), 328
DYSCHONDROPLASIA, bilateral, associated with osteogenetic exostosis of familial type (abs), 462
case of (abs), 597
ECHINOCOCCUS CYST in bone (abs), 712
secondary, of the lung (abs), 585
ECTRODACTYLIA, rare case of (abs), 96
EDITORIALS
The radiologists' liability insurance, 67
Carl S. Oakman, 68
The future of radiology as a specialty, 190
The Goulstonian Lectures on calcium and phosphorus metabolism, 303
The annual meeting, 434
Appointment of Dr. Morison as Professor of Radiology, University of London, 435
The early diagnosis of carcinoma of the stomach, 563
William B. Bowman, 567
Richard Mark Brown, 568
Concerted action in the fight against cancer, 687
EFFECT, analgesic, of roentgen rays (abs), 338
biological, of radium irradiation abs, 108
immuno-biologic, of mild roentgen irradiations on bactericidal power of blood (abs), 109
of cathode rays upon certain bacteria (abs), 348
or roentgen and radium radiation on tissue metabolism (abs), 220
(The) of Roentgen Irradiation on the Interrelation between Malignant Tumors and Their Hosts. By Carl Krebs. (B.R.), 444
of roentgen radiation, on lymphoid tissue, 42
of roentgen rays on bacteriophage and bacterial organism (abs), 347
of roentgen rays on basal metabolism (abs), 346
of roentgen rays, on central nervous system (abs), 340
of roentgen rays, on irradiated bodies (abs), 107
of roentgen rays, on vegetative nervous system (abs), 341; (abs), 346
ELBOW, osteochondromatosis of, case of (abs), 96
ELECTRICAL accident, 572
shock at 110 kv., laboratory accident (abs), 108
EMPYEMA, roentgen aspects of (abs), 701
ENCHONDROMAS, multiple, of both hands (abs), 96
ENDOTHELIOMA of tibia (abs), 596
EPILATION, roentgen injury after, and medicolegal judgment (abs), 336
thallium or roentgen rays for (abs), 335
EPIPHYSES of femoral heads in a child, unusual alterations (abs), 99
of vertebral bodies and their changes (abs), 592
EPIPHYSIS, of first metatarsal bone, isolated aseptic necrosis in (abs), 710
EPITHELIOMA of tongue, radium treatment (abs), 337
ERGEBNISSE der Medizinischen Strahlenforschung. Edited by H. Holfelder, H. Holthusen, O. Jüngling, H. Martius and H. R. Schinz. (B.R.), 578
ESOPHAGUS, anterior diverticulum of (abs), 324
barium enema entering, 300
cancer of (abs), 324
diverticula of (abs), 215
diverticulum of, rapid development of (abs), 450
idiopathic dilatation, genesis of (abs), 586
EWING'S sarcoma (abs), 463
tumor, nature of (abs), 464
EXOSTOSIS, osteogenetic, of familial type, associated with bilateral dyschondroplasia (abs), 462
EXPERIMENTAL STUDIES on Roentgen Treatment of Malignant Tumors. By Jens Juul (B.R.), 445
EYE, malignant tumors, treatment by radiation (abs), 223

FEMUR, diagnosis of impaction of fractures of neck of, by roentgenograms in three positions (abs), 332
FIBROANGIOMA of nasal cavity, roentgen therapy (abs), 472
FIBROMYOMA, uterine (abs), 91
FILMS, danger of fire from (abs), 468
FINGERS, unusual form of multiple developmental disturbance of, in adolescence (abs), 96
FISTULA, biliary, lipiodol studies of postoperative (abs), 90
cholecysto-colic (abs), 327
jejuno-colic (abs), 326
of biliary tract, lipiodol roentgen diagnosis of (abs), 709
FOREIGN BODIES in bronchi (abs), 703
of eye, simplification of graphic method of Grudzinski for localization of (abs), 698
FRACTURES, influence of roentgen rays on healing of (abs), 604
of cranium, rôle of osseous structures in (abs), 450
of hip (abs), 94
of neck of femur, diagnosis of impaction of, by roentgenograms in three positions (abs), 332
viewing of fluoroscopic reduction of, in two planes (abs), 714

GALL-BLADDER, cholecystography and function of (abs), 586
effect of x-rays on (abs), 107
emptying of, following restoration from acute experimental cyolecystitis (abs), 709

improvement of roentgen demonstration, 573
roentgen-physiological studies on, 634
Gastrointestinal tract, compressor and selective apparatus for relief study of (abs), 87
relief studies of (abs), 87
roentgen examination of bleeding affections of, by means of hydrogen peroxide contrast suspension (abs), 591
roentgen picture of, in a case of chronic dyspepsia (abs), 215
syphilis, roentgen picture (abs), 589
Gaucher's disease, roentgenologically demonstrable changes in bone in, 258
Goiter: See also Thyroid
changes in form and size of heart in (abs), 704
exophthalmic, importance of radiotherapy in (abs), 474
exophthalmic, roentgen treatment (abs), 103
results of roentgen therapy, based on observations in 400 cases, 395
toxic, ten years' results with radium in treatment of, 280
Goulstonian Lectures on calcium and phosphorus (E), 303
Granger, Amedee, reception to, 441

Halogenated oils, employed in roentgenology, study of (abs), 604
Hand, rare case of congenital malformation of (abs), 592
Hands, destruction of terminal phalanges in both (abs), 96
multiple enchondromas of both (abs), 96
Headaches, menstrual, 267
Heart, change of form and size of, in struma (abs), 704
enlargement of (abs), 584
functional capacity of, roentgen characteristics (abs), 704
horizontal orthoprojection of (abs), 704
isography and cinematography of (abs), 86
new principle for determination of size of, and its practical application (abs), 213
orthodiagrammeter for radioscopic examinations of (abs), 86
"Hemato-encephalic barrier," roentgen rays and (abs), 340
Hematoma, dissecting, of phrenic nerve, with anomalous enlargement of liver, 38
Hemorrhages, genital, roentgen study of sella turcica in (abs), 203
subcutaneous or mucous membrane, radium in treatment of diseases with (abs), 103
Hepatargia, attacks of, during roentgen treatment of Banti's disease (abs), 476
Hernia, diaphragmatic; phrenic nerve stimulation under fluoroscope as an aid in diagnosis (abs), 214
of stomach through esophageal orifice of the diaphragm (abs), 86
right diaphragmatic, of colon (abs), 588
roentgen examination of (abs), 328
Hickey, Preston M., honored, 199
notice of death of, 569
Hip, complicated traumatic dislocation of (abs), 599
congenital dislocation of (abs), 332
congenital dislocation of, diagnosis and early treatment (abs), 100
fractures of (abs), 94
Hodgkin's disease of bone (abs), 219
of the lungs (abs), 209
radiotherapy of (abs), 600
with involvement of bone and skeletal muscles (abs), 218
Hospital, modern, radiation service in (abs), 468
Humerus varus (abs), 592
Hydatid cyst of lungs, two cases (abs), 702
Hydrogen peroxide contrast suspension, roentgen examination of bleeding affections of gastrointestinal tract by means of (abs), 591
Hypochondrium, right, calcareous shadows in (abs), 587

Ileum, tumors of terminal loop of (abs), 590
Impetigo herpetiformis, roentgen castration in (abs), 334
Infancy and childhood, cystography in (abs), 457
diseases of urinary tract during (abs), 459
Infant, new-born, cardiospasm in (abs), 453
new-born, thymic shadows in (abs), 582
Infantile paralysis, mechanism of action of roentgen therapy in (abs), 601
Infants and children, pleurisy in (abs), 701
Inflammations, acute, radiotherapy (abs), 102
acute, roentgen therapy in (abs), 221
Injury, late, from roentgen irradiation (abs), 344
roentgen, after epilation, and medicolegal judgment (abs), 336
Insurance, radiologists' liability (E), 67
International Congress of Radiology, third, 71, 311
Intervertebral discs, appearance of, in typhoid spondylitis (abs), 97
cartilaginous nodes in posterior surface of (abs), 97
Intestine, small, stenosis of, following gastroenterostomy (abs), 453
Inthrathoracic diseases, differential roentgen diagnosis (abs), 85
tumors, roentgen treatment (abs), 104
Invagination, ileo-ceco-colic, Busi's roentgen sign in (abs), 454
Iodine salts, mechanism of sensitization by (abs), 347
Iodized oil, effect of injections of, in spinal subarachnoid space (abs), 710
Ionization chamber, rôle of large and small, in roentgen measurements (abs), 111
small thimble, physics of (abs), 112
Iridiocyclitis, tuberculous, treated with roentgen rays (abs), 469

Jaws, angio- (perivascular) endothelioma about, 534

Kidney, anomalous, case of, producing symptoms (abs), 455
case of double pelvis of and double ureter in both sides (abs), 330
multiple malignant adenomas of (abs), 330
new adjuvant for elimination of meteorism in roentgenography (abs), 330
pyelovenous backflow in (abs), 456
Köhler's disease of os naviculare tarsi, pathogenesis of (abs), 100
Kümmell's disease (abs), 333
Kyphosis, juvenile, pathogenesis of (abs), 593

Larynx, carcinoma, radiation treatment (abs), 337
Lead poisoning, roentgen sign of, 550
therapeutic, 169
Leg, case of eburnated osteosis of (abs), 597
healing of a giant tuberculous ulcer of (abs), 713
unusual congenital anomaly of bones of (abs), 599
Leucemia, blood changes in, and bearing on roentgen therapy, 648
Lipiodol, experiments with, on gall-bladder of dog, 634
in diagnosis of tumor of the uterus (abs), 329
in roentgen diagnosis of lesions of biliary tract in fistulae (abs), 709
intrabronchial injection in children by a new technique (abs), 703
studies of postoperative biliary fistulae by means of (abs), 90
Lithiasis, urinary, unusual types of (abs), 460
Liver, anomalous enlargement, with dissecting hematoma of phrenic nerve, 38
function of, and cholecystography (abs), 587
method for roentgen contrast visualization (abs), 326
primary idiopathic (abs), 218
Localization of Grudzinski, simplification of graphic method of (abs), 698
Lungs, azygos lobe, and clinical significance (abs), 699
azygos lobe, does demonstration of, represent important sign of pachypleuritis (abs), 325
azygos lobe, few cases of (abs), 325
azygos lobe, roentgen appearance (abs), 85
carcinoma, and pneumoconiosis of Ruhr miners (abs), 702
collapse, mechanism of obstructive (abs), 702
description of pathologic shadows in, in terms of clouds (abs), 700
effect of phrenicectomy on cavitation of, 626
Hodgkin's disease of (abs), 209
hydatid cysts of, two cases (abs), 702
lobus apicodorsalis, hitherto unknown localization of azygos lobe (abs), 585
massive collapse of (abs), 325
massive collapse, pulmonary embolism and (abs), 451
neoplasms of (abs), 452
postoperative complications and bronchial obstruction (abs), 702
primary carcinoma of (abs), 209
right field of, capillary line in (abs), 583
secondary echinococcus of (abs), 585
syphilitic infection of, 427
tumors, diagnosis in the adult (abs), 585
use of Bucky diaphragm in roentgenograms (abs), 107
Lupus vulgaris, treatment of (abs), 336
Lymph nodes, calcified, in mesentery, clinical study (abs), 218
Lymphogranulomatosis, irradiation of (abs), 338
prognosis of (abs), 101
Lymphoid tissue, reaction of, to roentgen radiation, 42
Lymphomata, blood changes in, and bearing on roentgen therapy, 648

Marble bones, contribution to knowledge of (abs), 95
development of, 147
Marie's disease (abs), 598
Measurement of penetrating radiations, technique (abs), 110
Measurements in radiation protection (abs), 109
roentgen, rôle of large and small ionization chamber in (abs), 111
Mecapion for measurement of borderline rays (abs), 111
Medical and Surgical Year-Book of the Physicians Hospital of Plattsburgh (B.R.), 446
Medicolegal judgment on roentgen injury after epilation (abs), 336
testimony, difficult case of (abs), 467
Menstruation, headaches of, 267
Mega-esophagus, case of (abs), 324
Menopause, curietherapy of hemorrhagic metropathy of (abs), 474
Mesentery, calcified lymph nodes in, clinical study (abs), 218
Metabolism, calcium and phosphorus, Goulstonian Lectures on (E), 303
tissue, effect of roentgen and radium radiation upon (abs), 220
Metatarsal bone, first, isolated aseptic necrosis in epiphysis of (abs), 710
Metropathy, hemorrhagic, of menopause, curietherapy (abs), 474
Metrorrhagia, essential, pathogenesis and roentgen treatment in young subjects (abs), 106
Mikulicz syndrome, treatment by irradiation, 491
Mikulicz's disease, and the Mikulicz syndrome (abs), 100
treatment by irradiation, 491
Minnesota Radiological Society 693
Mitral lesions, roentgen and clinical study of relation between pulmonary tuberculosis and (abs), 585

Morbus basedowii: See Goiter, exophthalmic
Morison, J. M. Woodburn, appointment of, as Professor of Radiology, University of London (E), 434
Mouth, carcinoma, radium treatment (abs), 470
carcinoma, what is essential for successful therapy (abs), 471
Mucocele of appendix and cecum, recognition of (abs), 88
Mycosis, osseous, roentgen study of case of (abs), 94
Myelography (abs), 462
Myeloma, case of solitary plasma-celled (abs), 331
Myomas of uterus, results of radiotherapy of, and hemorrhagic metropathies (abs), 341

Nasal cavity, fibroangioma, roentgen therapy (abs), 472
Neck, calcium shadows in region of soft tissues of (abs), 83
Neoplasms, cutaneous, treatment in single sitting with rays of medium penetration (abs), 469
of lung (abs), 452
Normale Anatomie des Kopfes im Röntgenbild. By Karl Goldhamer. (B.R.), 578
Nucleus pulposus, intervertebral, anatomy, physiology and pathology (abs), 594

Oakman, Carl S., obituary notice (E), 68
Orbit, malignant tumors of, treatment by radiation (abs), 223
Os naviculare tarsi, pathogenesis of Köhler's disease of (abs), 100
Osteitis deformans Paget of spinal column (abs), 96
sarcomatous degeneration of (abs), 712
Osteitis fibrosa (abs), 219
Osteochondritis dissecans (König), roentgen consideration (abs), 711
Osteochondromatosis, of elbow, case of (abs), 96
Osteoma of spinal column followed by hydronephrosis from compression of ureter (abs), 596
Osteomalacia, 29
Osteopathy, deforming, roentgen study of some cases of, of type of Paget (abs), 599
hunger, 29
Osteoperiostitis, hypertrophic pulmonary (abs), 598
Osteoporoses, painful post-traumatic (abs), 598
Osteoporosis circumscripta (Schüller), a rare but typical form of Paget's disease (abs), 219
Osteosis, eburnated of one limb (abs), 597
Ovary, carcinoma of, report of three cases treated by deep roentgen therapy, 63
cystoma of, importance of pneumoperitoneum in differential diagnosis from ascitic form of tuberculous peritonitis (abs), 455

Pacchionian bodies, generalized pressure atrophy of brain secondary to traumatic and pathologic involvement of (abs), 324
Pachypleuritis, does demonstration of azygos lobe represent an important sign of (abs), 325
Paget' disease, bone tumors in (abs), 599
Pancreas, cystic tumors of, diagnosis (abs), 455
diverticulum of duodenum perforated into, 684
Papilloma of duodenum, roentgen diagnosis, 554
Paronychia, chronic, roentgen treatment (abs), 334
Patella, deformities, following fracture (abs), 220
Pelvis, organs of female, roentgen examination (abs), 709
Peribronchitis, tuberculous (abs), 326
Peritoneum, roentgenology of (abs), 455
Peritonitis, tuberculous, importance of pneumoperitoneum in differential diagnosis from cystoma of ovary (abs), 455
Pes valgus, juvenile, development of (abs), 600
Phrenic nerve, dissecting hematoma of, 38
Phrenicectomy, effect of, on pulmonary cavitation, 626
Phthisis: See Tuberculosis
Pituitary gland, tumors of, treatment by roentgen rays and surgery (abs), 338
Pleura, calcification of (abs), 325
Pleural adhesions, diagnosis (abs), 701
effusion, mediastinal, roentgen study, 225
Pleurisy in infants and children (abs), 701
Pleuritis, apical cortico-pleuritis and (abs), 583
apical, roentgen examination of (abs), 451
Plumbism, roentgen sign of, 550
Pneumoconiosis of Ruhr miners and lung carcinoma (abs), 702
Pneumoperitoneum, importance in differential diagnosis between cystoma of ovary and ascitic form of tuberculous peritonitis (abs), 455
Pneumothorax, remarks on (abs), 212
Polarizer, automatic, for synchronous rectifier, 317
Polyarthritis, severe chronic infantile, and its sequelae (abs), 92
Polyposis, multiple, of colon (abs), 454
Pott's disease, lumbosacral (abs), 98
Pregnancy, value of lateral view in diagnosis of (abs), 709
Prostate, cancer of (abs), 461
carcinoma, value of high voltage x-ray therapy (abs), 472
Prostatic area, sarcoma of, in an infant aged four months, 185
Protection, integral, new improved model (abs), 714
measurements in radiation (abs), 109
Pseudofractures (hunger osteopathy, late rickets, osteomalacia), 29
Psittacosis (abs), 451
Pterygium, degenerative recurrent, roentgen treatment (abs), 601
Pyelography, intravenous (abs), 591
Pylorus, hypertonicity and hypertrophy of, in adults (abs), 216
Pyopneumothorax, subphrenic, from perforation of ulcer of colon (abs), 588

r (international unit) evaluation of cutaneous reactions in, and in R (Solomon (abs), 110
RADIATION, experimental studies on tissue reaction to, using a segment of growing mouse tail as biological indicator, 640
service in modern hospital (abs), 468
RADIOLOGISTS' liability insurance (E), 67
RADIOLOGY as a specialty, future of (E), 190
progress of survey of, 71
"RADIOPHOT" (abs), 111
RADIUM, and roentgen therapy, clinical evaluation of, in advanced cancer, with various combinations of wave lengths, 540
carriers, how to make (abs), 345
department of St. Bartholomew's Hospital, London (abs), 102
detection, estimation and elimination of, in living persons given radium chloride internally, 418
method for making surface applicators, plaques and packs, 442
proper storage of, 573
rays, artificial (abs), 111
teletherapy (abs), 337
therapy, superficial, construction of apparatus of Columbia paste for (abs), 101
RADIUMBEHANDLUNG (DIE) in der Augenheilkunde By Leo Kumer and L. Sallmann. (B.R.) 445
RADIUMTHERAPIE, Methoden und Aussichten. By F. Gudzent. (B.R.), 695
RADIUS, bilateral congenital subluxation of head of (abs), 92
RADON, method for making surface applicators, plaques and packs, 442
RAYONS (LES) ultraviolets et infra-rouges. By W. Vignal. (B.R.), 320
RECKLINGHAUSEN'S DISEASE, two cases of (abs), 332
RECTIFIER, synchronous, automatic polarizer for, 317
RECTUM, cancer, advantages and limitations of radiation in treatment of (abs), 343
cancer, inoperable, curietherapy with method of Neumann and Coryn (abs), 106
carcinoma, radium treatment (abs), 473
malignant tumors, treatment by radium and roentgen rays (abs), 343
RESPIRATION, effect of abdominal operations on mechanism of (abs), 451
RIB, sarcoma of, 262
RICKETS, late, 29
renal (abs), 711
ROENTGEN apparatus, raising of tariff on imported, in Hungary, 310
diagnosis, new possibilities in, 309
ray generating apparatus, development of modern, 605
ROENTGENOLOGICAL CONFERENCE, Baltimore, Maryland, 574
ROENTGENOLOGY, Radiology, and Cancer Research, State Institute for, in Leningrad (abs), 344

SACROILIAC JOINT, symphysis pubis in roentgen examination of, 621
SACRUM, anomaly of (abs), 333
ST. BARTHOLOMEW'S HOSPITAL, London, radium department of (abs), 102
SARCOMA, Ewing's (abs), 463
lymphoblastic, of tonsil and inferior carotid region (abs), 600
of prostatic area in an infant aged four months, 185
of rib, 262
of thyroid gland (abs), 83
of tibia, permanent cure of, and atrophy of irradiated muscles (abs), 344
SCAPHOID, carpal, bilateral congenital malformation of (abs), 592
SCLERODERMIA, roentgen therapy (abs), 469
roentgenograms of peculiar case of (abs), 95
SELLA TURCICA, roentgen study of, in hemorrhagic metropathy (abs), 203
SENSITOMETRIE (LA) cutanée. By J. Saidman. (B.R.), 320
SENSITIZATION, roentgen studies of (abs), 347
SEPTUM PELLUCIDUM, defects of, in encephalogram (abs), 698
SERIALOGRAPH, automatic electric horizontal and vertical, 200
SHOULDER, partial calcification of articular capsule of, radiotherapy (abs), 102
SINUS, interpretation of roentgenograms of, 21
SINUSES, maxillary, iodized oil as aid in diagnosis of chronic disease of (abs), 699
nasal accessory, and nasopharynx, treatment of malignant growths of (abs), 223
nasal accessory, roentgenology of (abs), 699
new apparatus for roentgenography of (abs), 699
SINUSITIS, incidence of, in asthmatic children (abs), 450
maxillary, dental caries as contributing factor in (abs), 698
SKELETON, biotypy of (abs), 592
SKIN, cancer, results of roentgen treatment (abs), 333
diseases, dose measurement and filtration of roentgen rays in (abs), 468
diseases, general roentgen irradiation with very small doses (abs), 335
diseases, indirect roentgen irradiation (abs), 334
diseases, superficial roentgen therapy (abs), 469
diseases, treatment results with Bucky borderline rays (abs), 338
diseases, treatment with borderline rays (abs), 103
neoplasms, treatment of, in single sitting with rays of medium penetration (abs), 469

normal and diseased, course of radium reactions on (abs), 221
reactions in r (electrostatic) and in R (Solomon), evaluation (abs), 110
roentgen treatment of burns and cauterization of (abs), 221
sensitized roentgen irradiated, histology of (abs), 108
stereoscopic visualization of, in roentgenograms (abs), 107
Skull, stereoprojections of (abs), 203
Solar plexus, roentgen irradiation of (abs), 476
Spina bifida, relation between and male impotence (abs), 596
Spine, disturbances of development of (abs), 333
giant cell tumor of (abs), 92
osteitis deformans Paget of (abs), 96
osteoma of, followed by hydronephrosis from compression of ureter (abs), 596
roentgenograms of (abs), 97
study of lumbosacral region (abs), 98
Spleen, method for roentgen contrast visualization (abs), 326
roentgenoscopy and roentgenography of (abs), 91
Spondylitis, infectious, clinical and roentgen study (abs), 595
typhoid, appearance of intervertebral discs in (abs), 97
deformans, with cord symptoms (abs), 331
Spondylolisthesis, roentgen picture (abs), 220
traumatic sub- and total luxation in lumbosacral region and so-called prespondylolisthesis (abs), 593
Stenosis, congenital, of pulmonary artery, roentgen image, with simultaneous defect of ventricular septum (abs), 583
of small intestine following gastroenterostomy (abs), 453
Stereograms, reading of, with aid of binoculars (abs), 345
Stomach, affections, roentgen treatment (abs), 602
carcinoma, early diagnosis (E), 563
congenital biloculation, with intrathoracic pocket or hernia of the diaphragmatic hiatus (abs), 87
empty, motility of, in normal and in malnourished asthenic children (abs), 453
hernia of, through esophageal orifice of diaphragm (abs), 86
interpretation of symptoms connected with (abs), 87
pseudodiverticula of antrum of (abs), 589
rapid emptying of, roentgen picture of right colon in (abs), 454
roentgen appearance of benign diverticular growths of (abs), 327
roentgen diagnosis of syphilis of (abs), 87
roentgen observation of benign tumors of (abs), 706
symptomatology and diagnosis of cardiaproximal diverticula of (abs), 586 ulcers, newer radiation therapy of (abs), 602
Subarachnoid space, spinal, effect of injections of iodized oil into (abs), 710
Suprarenal region, irradiation in vasoconstriction and vasodilatation of extremities (abs), 603
Suprarenals, radiotherapy of region of (abs), 105
Suture diagnosis, clinical application of roentgen (abs), 698
Symphysis pubis in roentgen examination of sacroiliac joint, 621
tuberculosis of (abs), 593
Syphilis, gastric, roentgen diagnosis (abs), 87
late hereditary, bone lesions in, 234
of gastrointestinal tract, roentgen picture of (abs), 589
of lung, 427

Teeth, roentgen studies of, in children (abs), 204
Teletherapy, radium (abs), 337
Television, application of principles of, in roentgenology (abs), 111
Thorax, roentgenography in transverse position (abs), 586
Thumbs, three-jointed (abs), 96
Thymoma, roentgen diagnosis and treatment (abs), 83
Thymus, hyperplasia of, a study of 1045 patients, 523
shadows in new-born infants (abs) 582
Thyroglossal duct cyst and sinus, 424
Thyroid, diseases of, roentgen diagnosis and therapy (abs), 103
metastases in bone (abs), 465
sarcoma of (abs), 83
value and place of radium in treatment of diseases of, 283
Tibia, endothelioma of (abs), 596
sarcoma, permanent cure of, and atrophy of irradiated muscles (abs), 344
Tissue reaction to radiation, experimental studies, using a segment of a growing mouse tail as biological indicator, 640
Tongue, carcinoma of, cured for six years by roentgen treatment alone (abs), 224
treatment of epithelioma of, by radium (abs), 337
Tonsil, lymphoblastic sarcoma of, and inferior carotid region (abs), 600
Tordiol, for roentgen contrast visualization of spleen and liver (abs), 326
Tuberculosis, acute subapical versus insidious apical (abs), 205
early diagnosis of (abs), 204
ileocecal, early, diagnosis of, 367
in school children (abs), 207
intestinal, study of, among ex-service men (abs), 707
intestinal, comparative radiographic and anatomical studies of (abs), 216

latent, percentage of, and primary complexes demonstrable roentgenologically in children of a rural district (abs), 584
of acromioclavicular joint (abs), 95
of sigmoid colon simulating primary malignant lesion (abs), 89
of symphysis pubis (abs), 593
of vertebrae, roentgen study for demonstration of, at an early stage (abs), 93
peribronchial (abs), 326
pulmonary, fatal, duration of (abs), 452
pulmonary, incipient in young adults, infraclavicular foci of infiltration as evidence of (abs), 84
pulmonary, intercleido-hilar onset of (abs), 700
pulmonary, miliary, experimental contribution to roentgen diagnosis (abs), 700
pulmonary, of adults, complementary researches on (abs), 84
pulmonary, roentgen and clinical study of relation between mitral lesions and (abs), 585
TUMOR, Ewing's, nature of (abs), 464
giant cell, of spine (abs), 92
TUMORS, benign diverticular, of stomach, roentgen appearance (abs), 327
benign, of stomach, roentgen observations on (abs), 706
bone, in Paget's disease (abs), 599
cystic, of pancreas, diagnosis (abs), 455
factors determining radioresistance of (abs), 222
malignant, importance of filtration and superiority of pure gamma radiation in radiotherapy of (abs), 106
malignant, of eye and orbit, treatment by radiation (abs), 223
malignant, of nasal accessory sinuses and nasopharynx, treatment of (abs), 223
malignant, of rectum, treatment by radium and roentgen rays (abs), 343
malignant, treatment with radium catgut (abs), 337
of bladder, management of (abs), 460
of lung, in adult, diagnosis (abs), 585
of terminal loop of ileum (abs), 590
pituitary, treatment by roentgen rays and surgery (abs), 338
ULCER bearing area, anatomical consideration (abs), 707
duodenal, diagnosis of niches in (abs),88
duodenal, roentgen examination of perforation of (abs), 589
duodenal, usefulness of roentgen signs (abs), 328
gastrojejunal and jejunal, direct roentgen signs (abs), 707
of colon, subphrenic pyopneumothorax from perforation of (abs), 588
of stomach, newer radiation therapy (abs), 602
tuberculous of leg, healing of (abs), 713
ULCUSPROBLEM (DAS) in Lichte moderner Röntgenforschung. By H. U. Albrecht. (B.R.), 694
ULTRAVIOLET RADIATIONS and Their Uses. By Robert Aitken. (B.R.), 695
URETER, migrating calculi of (abs), 591
URETERAL KINKS; how they occur at order "take a deep breath and hold it" (abs), 710
URETHROGRAPHY, technique of (abs), 329
URINARY TRACT, complications in, due to carcinoma of uterine cervix or radiation treatment, 47
diseases of, during infancy and childhood (abs), 459
UTEROSALPINGOGRAPHY, data on (abs), 329
UTERUS, cancer, chief point in struggle against (abs), 335
carcinoma, treatment of, 412
cervix, cancer, résumé of work of subcommittee charged with study of radiotherapy of (abs), 603
cervix, carcinoma, dosage of hard roentgen rays from distant fields in treatment (abs), 342
cervix, carcinoma, investigation of relation between histological findings and results of radiation therapy (abs), 474
cervix, carcinoma, results from treatment with radium and roentgen rays 1915–1923, 54
cervix, carcinoma, results obtained in treatment with radium and x-rays (abs), 343
cervix, complications in urinary tract, due to carcinoma of, 47
fibromyoma of (abs), 91
histological study of mucous membrane of, after roentgen castration (abs), 474
results of radiotherapy in myomas of, and hemorrhagic metropathies (abs), 341
tumor of, lipiodol diagnosis (abs), 329
VASA DEFERENTIA, case of almost total calcification of (abs), 591
VEGETATIVE NERVOUS SYSTEM, effect of roentgen rays on (abs), 341; (abs), 346
VERTEBRA, dorsal, unusual appearance of (abs), 594
twenty-fourth, anomalous sacrolumbar band of bone in cases of sacralization of (abs), 595
VERTEBRAE, cartilaginous islands of, roentgen appearance (abs), 92
erosion of, from aneurysm (abs), 712
ivory (abs), 98
post-traumatic malformation, giving appearance of osteomalacia (abs), 99
tuberculosis of, roentgen study for demonstration of, at an early stage (abs), 93
VERTEBRAL BODIES, epiphyses of, and their changes (abs), 592
simulated horizontal division of, in roentgenogram (abs), 711
VIENNA LETTER, 309, 572
VISCEROPTOSIS, clinical significance (abs), 705

WESTINGHOUSE forms x-ray company, 312

X-RAY CRYSTALLOGRAPHY. By R. W. James. (B.R.), 694

"ZONES OF ACTION" in irradiated bodies (abs), 107

AUTHOR INDEX TO VOLUME XXIV

Adams, W. E., 702
Adler, Karl, 220
Airale, 450, 585, 596
Aitken, Robert, 695
Akaiwa, Hachiro, 42
Albrecht, H. U., 694
Alquier, A., 96
Altman, J., 703
Anderson, John H., 454
Arkussky, I., 583, 704
Armand-Delille, P.-F., 703
Arnone, G., 592
Arntzen, Leif, 330
Arons, Isidore, 83
Assmann, H., 84
Asti, Luigi Mario, 101
Aubertin, Ch., 600
Auchincloss, Hugh, 218

Bagdasaroff, A., 602
Bagg, Halsey J., 640, 647
Ball, Howard A., 101
Bargen, J. Arnold, 89
Barker, Howard H., 418
Barnes, Harry L., 452
Barnes, Lena R. P., 452
Barreau, 96, 97
Barros, Enrique, 451
Bársony, Th., 83, 219, 585
Bauer, Richard, 587
Baum, Harry L., 699
Baumann, Ernst, 711
Baumeister, W., 586
Bean, Harold C., 593
Beck, A., 334
Beck, Emil G., 178
Beckwith, T. D., 347
Beilin, D. S., 705
Belden, Webster W., 103
Belot, 96
Belot, J., 467, 714
Benhamon, Ed., 91
Benjamin, Emanuel W., 90
Berg, Hans H., 87
Bergmann, O., 450
Bering, Fr., 469
Bernard, Léon, 700
Berry, Gordon, 698
Beutel, Alois, 586
Bianchini, A., 591
Binkley, George E., 343
Birkett, G. E., 470
Blackford, John M., 87
Bliss, J. Herbert, 54
Blond, Kaspar, 586
Bode, H.-G., 108
Böhm, Max, 600
Boon-Itt, S. B., 389
Borak, J., 338, 474
Bordet, Emile, 85
Bouchacourt, L., 714
Bowing, Harry H., 54, 60, 62, 343
Braasch, William F., 460
Bradford, John Rose, 325
Brams, Julius, 107
Brandt, W., 336
Brauer, A., 103
Braun, Oskar, 345
Braun, R., 112
Brdiczka, I. G., 589
Brillouet, 600
Broc, Renè, 87, 702
Bromer, Ralph S., 153
Bruner, Edward, 103
Brunn, Harold, 708
Bumpus, Hermon C., Jr., 710
Buonamici, C. Banci, 598
Burke, E. M., 474
Burpee, Claude, 711
Busi, A., 584
Bustin, E., 204

Calvé, Jacques, 594
Camp, John D., 707
Campbell, Meredith F., 457
Canti, R. G., 108
Carling, Francis Rock, 337
Casati, A., 107, 330
Case, J. T., 19
Castleton, Kenneth B., 234
Catalano, Orlando, 588
Chamberlain, W. E., 621, 655
Chantraine, H., 111
Charlier, 333
Chaumet, G., 84, 583
Chipman, Ernest D., 467
Chobot, Robert, 450
Codet, 96
Cohn, Max, 107
Cola, 472, 476, 596
Connell, W. W., 465
Coolidge, W. D., 605
Copeland, Murray M., 89, 463, 464
Coryllos, Pol. N., 702
Cottone, G., 587, 589
Crandall, L. A., 604

Dann, David S., 154
Darbois, 87, 589
Darnbacher, Leo, 107
Dauvillier, A., 111
Davis, Loyal, 710
Dawson, Warren R., 579
de Las Casas, Herman, 98
Debenham, R. K., 455
del Buono, P., 106, 346
Delario, A. J., 516
Delherm, 98, 585
Denier, 713
Desjardins, Arthur U., 54
Desplats, 603
Desplats, R., 105
Didiée, 586
Dillenseger, 327, 586
Dinkin, L., 591
Dioclès, 87, 345
D'Istria, A., 597, 712
Donaldson, Sam W., 523
Dossot, Raymond, 461
Douarre, 332
Doub, Howard P., 83
Douglas, Bruce H., 205
Dunay, Beatrix, 602
Duval, 451
Dwyer, Maurice F., 87

Einhorn, Moses, 200, 707
Epifanio, G., 455, 476
Evans, Newton, 101
Evans, William A., 104, 673
Ewing, James, 222
Failla, G., 80
Fairbank, H. A. T., 332
Fanardshew, Bartholomaus, 88
Farrell, John T., Jr., 140
Fay, Temple, 324
Feldman, Maurice, 88
Fenger, E., 207
Fernau, Albert, 345
Fineman, Solomon, 26
Florin, Marie, 474
Fontaine, R., 598
Francesco, G., 595
Fray, Walter W., 349
Freund, L., 221
Fricke, Robert E., 343
Friedenwald, Julius, 88
Friedrich, H., 219
Fritsch, Hans, 430
Fuchs, Felix, 456
Fuhs, H., 334, 335
Fukase, Shuichi, 603
Fuller, C. J., 327
Fürst, Walter, 342
Fusari, A., 95

Gabriel, G., 341
Galewsky, E., 468
Galifi, Liborio, 583
Galland, Marcel, 98, 594
Garcia Calderon, 328, 453
Garcin, 327
Gargiulo, Mario, 454, 469, 601

Gask, G. E., 337
Gaudin, Charles, 86
Gauducheau, R., 106, 600
Gershon-Cohen, J., 367
Geschickter, Charles F., 463, 464
Gianturco, C., 214
Gilman, Robert L., 234
Ginsburg, Solomon, 283, 299
Ginzburg, Leon, 90
Glaser, Mark Albert, 477
Glocker, R., 109, 468
Goette, K., 203
Goldbloom, A. Allen, 313
Goldhamer, Karl, 578
Goosman, Charles, 656
Grado, 454
Grier, G. W., 21, 28, 298, 709
Grier, James P., 330
Griffith, J. P. Crozer, 100
Groover, T. A., 191, 409
Grütz, O., 334
Gudzent, F., 695
Gueben, Georges, 110
Gunsett, A., 110

Habermann, R., 336
Hahn, Otto, 698
Halberstaedter, L., 337
Hallermann, W., 96
Halpert, Béla, 634
Halter, C. Robert, 640
Hansen, N. A., 604
Haven, A., 710
Hefke, Hans W., 258
Healy, William P., 415
Held, A., 209
Held, I. W., 313
Hellner, Hans, 593
Henrard, E., 108
Herz, Richard, 344
Hickey, P. M., 124
Higgins, George M., 709
Hirsch, H., 336
Hirsch, Henri, 222
Hirschberg, M., 343
Hoffman, J. M., 103
Holfelder, H., 578
Holly, Leland E., 363
Holman, Emile, 84
Holthusen, H., 578
Holzknecht, G., 103
Hopwood, F. L., 102
Huet, J.-A., 87, 451, 591
Hutter, Howard J., 427

Imperatori, Charles J., 705
Isaacs, Raphael, 648, 656

Jacobs, A. W., 63
Jacobs, J., 338
Jahiel, 328, 453
Jalet, 325
Jalet, J., 325
James, R. W., 694
Janker, Robert, 592
Jansson, Gösta, 711
Jarcho, Julius, 709
Jarre, Hans A., 575
Jaubert de Beaujeu, A., 87, 702
Jaulin, 92
Jenkinson, E. L., 215
Jeanneney, G., 450
Johnson, E. T., 218
Jones, E. Lloyd, 699
Jones, Oswald R., 209
Joseph, Eugen, 337
Judd, E. Starr, 330
Jugenburg, Anna, 346
Junghagen, Sven, 331
Junghanns, Herbert, 220
Jüngling, O., 578
Juul, Jens, 445

Kantor, John L., 1, 20
Kaplan, Ira I., 442
Karrenberg, C. L., 335
Kasabach, H. H., 262
Kauffmann, 96
Kaufmann, Mme., 709
Kaufmann, Robert, 709
Kerby, James P., 569
Kienböck, R., 92, 219
Kimpel, 96
Kirklin, B. R., 68, 258
Klason, T., 704
Knutsson, Folke, 329, 468
Kohn, S. E., 582
Kolta, Erwin, 602
Konrad, J., 334, 338
Kopelmann, S., 602
Koppenstein, Ernst, 219, 585
Kopylow, M. B., 95
Kornblum, Karl, 38
Koyama, M., 221
Krabbe, Knud H., 324
Krause, Paul, 473
Krebs, Carl, 444
Kreuz, Lothar, 99
Krönig, F., 223
Kuhlenbeck, Hartwig, 698
Kuhlmann, B., 101
Kumer, Leo, 445
Küstner, Hans, 111, 112

Laborde, Simone, 603
Lacassagne, A., 106
Lachapèle, 592
Lamy, 99
Langeron, 603
Langeron, L., 105
Lapeyre, 324
Laquerrière, 95
Laszlo, Edith, 582
Laurell, Hugo, 328
Law, F. M., 27
Leddy, Eugene T., 657
Ledoux-Lebard, 328, 453
Legge, Robert T., 178
Leist, M., 204
Lepennetier, 99
Lepennetier, F., 703
Leriche, R., 598
Leucutia, T., 104, 491, 673
Leunda, J., 703
Lévesque, 600
Lévy, Robert, 600
LeWald, Leon T., 153
Limouzi, 92
Linser, Karl, 468
Lloyd, John J., 703
Lockhart-Mummery, J. P., 473
Lockwood, I. H., 218
Loucks, R. E., 60, 280, 298, 539
Lucinian, Joseph H., 684
Lüdin, Max, 462
Ludwig, Haas, 698
Lynch, Frank W., 91
Lyon, Ernst, 97
Lyons, Clinton G., 300
Madlener, M. J., 220

Mahler, Paul, 586
Maire, 324
Malnekoff, B. J., 450
Mandeville, F. B., 713
Marchioni, R., 91
Marko, D., 701
Marks, Jerome A., 1
Marlock, H. V., 325
Martin, Charles L., 267, 279
Martius, H., 578, 710
Marxer, O. A., 454
Mathes, Mary E., 84
Mathey-Cornat, 599
Mattill, P. M., 207
Matusoff, Irving, 467
Matz, Philip B., 707
May, E. A., 221
McNamee, E. P., 125
McCarthy, Joseph F., 460
Meland, Orville N., 468
Menees, Thomas O., 363
Meyer, M., 94
Meyer-Borstel, H., 704
Michajlow, Mich., 92
Milani, Eugenio, 462, 597
Milkman, L. A., 29
Miller, James A., 209
Miller, J. Duane, 363
Mirto, Domenico, 596
Mirizzi, P. L., 455

Mogilnitzky, B. N., 340
Moore, Sherwood, 20
Morel-Kahn, 98, 585
Morrison, Theodore H., 88
Morton, Charles B., 216
Mulder, Denis, 713
Murphy, George T., 709

Narr, F. C., 218
Naumann, H., 325
Nebout, 96
Neill, William, Jr., 412, 417
Nemenow, M. I., 344
Newcomet, W. S., 646
Newell, R. R., 27, 80
Nichita, M. I., 100
Nicotra, A., 472, 474, 592, 595

O'Brien, E. J., 626
Ochsner, Alton, 208
Olson, A. R., 347
Ott, Ad., 700
Overholt, Richard H., 214

Paas, H. R., 220
Paisseau, 95
Palmer, Dorwin L., 699
Pancoast, H. K., 655, 690
Paolucci, R., 584
Parry, Leo D., 341
Paschetta, Vincent, 332
Paterson, Ralston, 701
Patey, D. H., 451
Peirson, Edward L., 472
Pelissier, G., 324
Pendergrass, E. P., 234
Pesme, Paul, 582
Pfahler, G. E., 341, 395, 410, 656
Pfalz, G. J., 109
Pflaumer, 327
Phelan, E., 207
Phemister, D. B., 466
Piccinino, G., 588, 601
Piffault, 96, 97
Pignataro, E., 589
Pinchin, A. J. S., 325
Pinner, Max, 205
Pirie, A. Howard, 147, 153
Podesta, V., 215, 217
Podlasky, H. B., 582
Podljaschuk, L. D., 340
Pollack, Herbert, 329
Popović, Laza, 85, 212
Pottenger, F. M., 204
Price, A. E., 491
Priesel, R., 85, 204
Profitlich, P., 111

Quick, Douglas, 223

Raap, Gerard, 185
Radt, Paul, 326
Rankin, Fred W., 89
Reeves, Robert J., 262
Reichert, F. L., 84
Remer, John, 103
Renander, Axel, 333
Reuss, A., 109
Rewbridge, Allan G., 634
Reynolds, Lawrence, 303, 434, 563
Rhodes, George K., 708
Riecke, E., 108
Rigler, Leo G., 225, 706
Risse, O., 345
Ritter, H., 335
Ritvo, Max, 86
Rivers, Thomas M., 348
Roberts, Percy W., 599
Robinson, G. Allen, 298
Rodenbaugh, Frederick H., 223
Roederer, C., 333
Rogers, Herbert, 331
Rohrbach, R., 334
Rose, E. J., 347
Rosenbaum, George, 558
Roth, M., 102
Rubinstein, D. L., 347
Runowa, M. F., 95
Rupp, Alice, 453
Ruth, C. E., 94
Ruth, V. A., 94

Sagel, Jacob, 225
Saidman, J., 320
St. Dedic, 584
St. Jianu, 329, 591
St. Simon, 343
Sallmann, L., 445
Sanders, Robert Lee, 213
Sandstrom, Carl, 327
Santoro, Mario, 454
Santos, José V., 92
Sauer, Walter, 100
Schechter, Samuel, 1
Schérer, 95
Schinz, H. R., 578
Schlundt, Herman, 418
Schmidt, W., 223
Schmitz, Henry, 47, 60
Schmorl, Georg, 97, 593
Schoenholz, L., 336
Schoenthal, Ludwig, 711
Schrader, Erwin, 96
Schreus, H. Th., 347
Schulte, G., 224, 702
Schultz, Frederic W., 453
Schurch, O., 471
Schwartz, Joseph, 218
Seiffert, A., 337
Segar, Louis H., 453
Semenza, Carlo, 326
Seulberger, P., 223
Sgalitzer, Max, 93
Sichel, D., 94
Siebert, Werner W., 700
Singer, S., 85
Sittenfield, M. J., 180
Skinner, E. H., 568, 647
Smith, George G., 472
Smith, N. D., 343
Smith, S. Watson, 333
Snoke, Paul O., 424
Sobel, 87, 589
Soiland, Albert, 104, 468
Stacy, Leda J., 54, 416
Stankiewicz, Zygmunt, 698
Steinbach, M. Maxim, 216
Steiner, E., 102
Stephani, Jacques, 107
Stephenson, F. B., 656
Stephenson, George W., 38
Stevens, Rollin H., 59
Stevens, William E., 459
Stoeffler, Walter, 453
Stoloff, E. Gordon, 701
Stone, Robert S., 701, 712
Stone, Theodore T., 710
Strasser, Ulrich, 587
Strauss, Siegmund, 111
Stuhl, L., 603
Stumpf, Pleikart, 86
Stumpke, G., 333
Surmont, J., 324, 329
Sussman, Marcy L., 163, 312
Sutherland, Charles G., 94

Tabern, D. L., 604
Taft, Robert B., 72, 80, 317
Takeshima, Mitsuzo, 42
Talia, F., 203
Tamiya, Ch., 213, 221
Taylor, R. G., 567
Temel, Tarik, 592
Templeton, H. J., 467
Teposu, E., 591
Teschendorf, Werner, 203, 328
Thibaudeau, A. A., 474
Thompson, Gershom J., 710
Thoyer-Rozat, 600
Towne, Edward B., 338
Tranier, 469
Tscherepnina, M., 92
Turano, Luigi, 591, 594

Ullmann, H. J., 179, 278, 297, 646

Van Allen, C. M., 702
Vastine, Jacob H., 395
Vignal, W., 320
Vischia, Quintino, 585

Vita, Giulio, 455
Vogt, Edward C., 550
Vollmar, F., 699
Volwiler, E. H., 604
v. Albertini, A., 712
von Ammon, Ernst, 341
von Glahn, William G., 452
v. Jaschke, R. T., 335
Vorhaus, Martin G., 88

Wagner, Aage, 710
Walter, E., 102
Walton, Henry J., 631
Wangermez, Ch., 450
Warren, Stafford L., 113
Washburn, Alfred H., 475
Waters, Charles A., 554
Weatherwax, J. L., 540
Weber, H. M., 217
Weil, S., 96
Weinstein, Samuel, 631
Weiss, Konrad, 219
Werner, R., 473
Werner, Walter I., 626
Westermark, Nils, 601
Wheatley, L. F., 679
Widmann, Bernard P., 540
Winkelstein, Asher, 706
Wissing, Ove., 324
Withers, Sanford, 169, 534
Wolff, Ernst, 701
Wood, Francis Carter, 179
Worning, Borge, 330
Wyckoff, Ralph W. G., 348

Zadek, Isadore, 599
Zorzoli, P., 326
Zuppa, A., 469

VOLUME XXIV DECEMBER, 1930 NUMBER 6

DEC 2 6 1930

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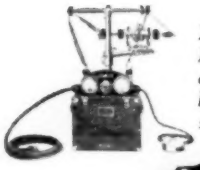

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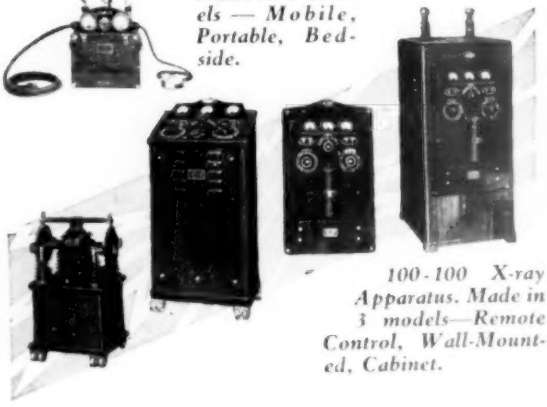

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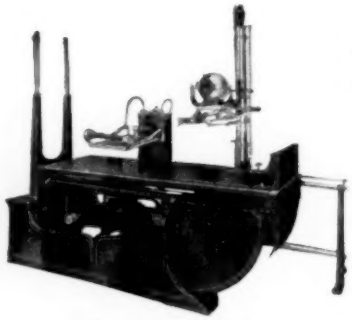

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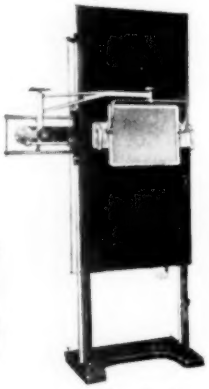

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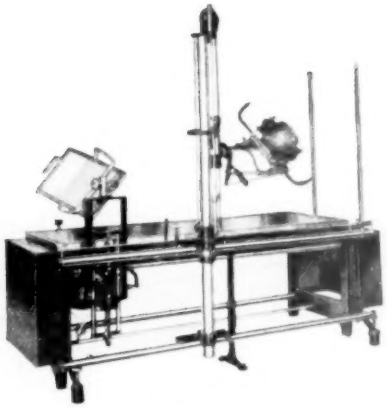

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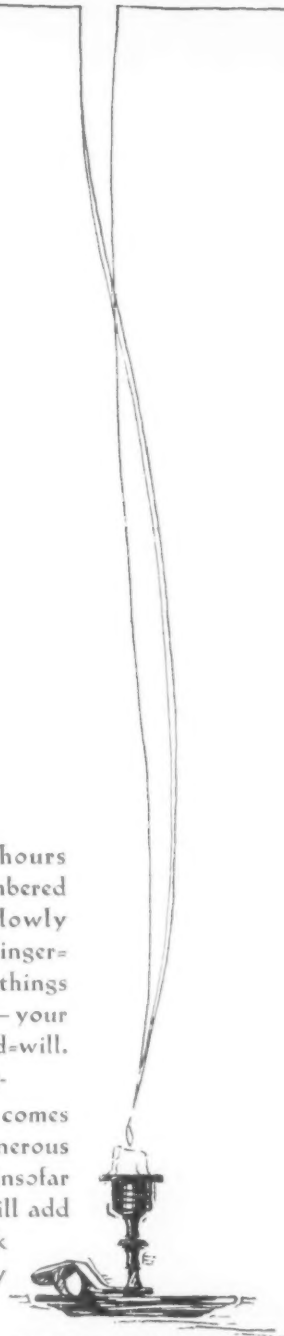

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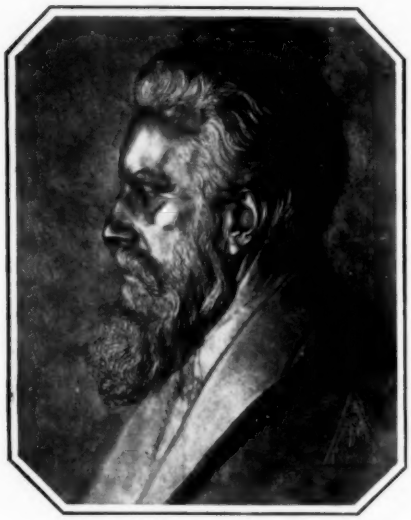

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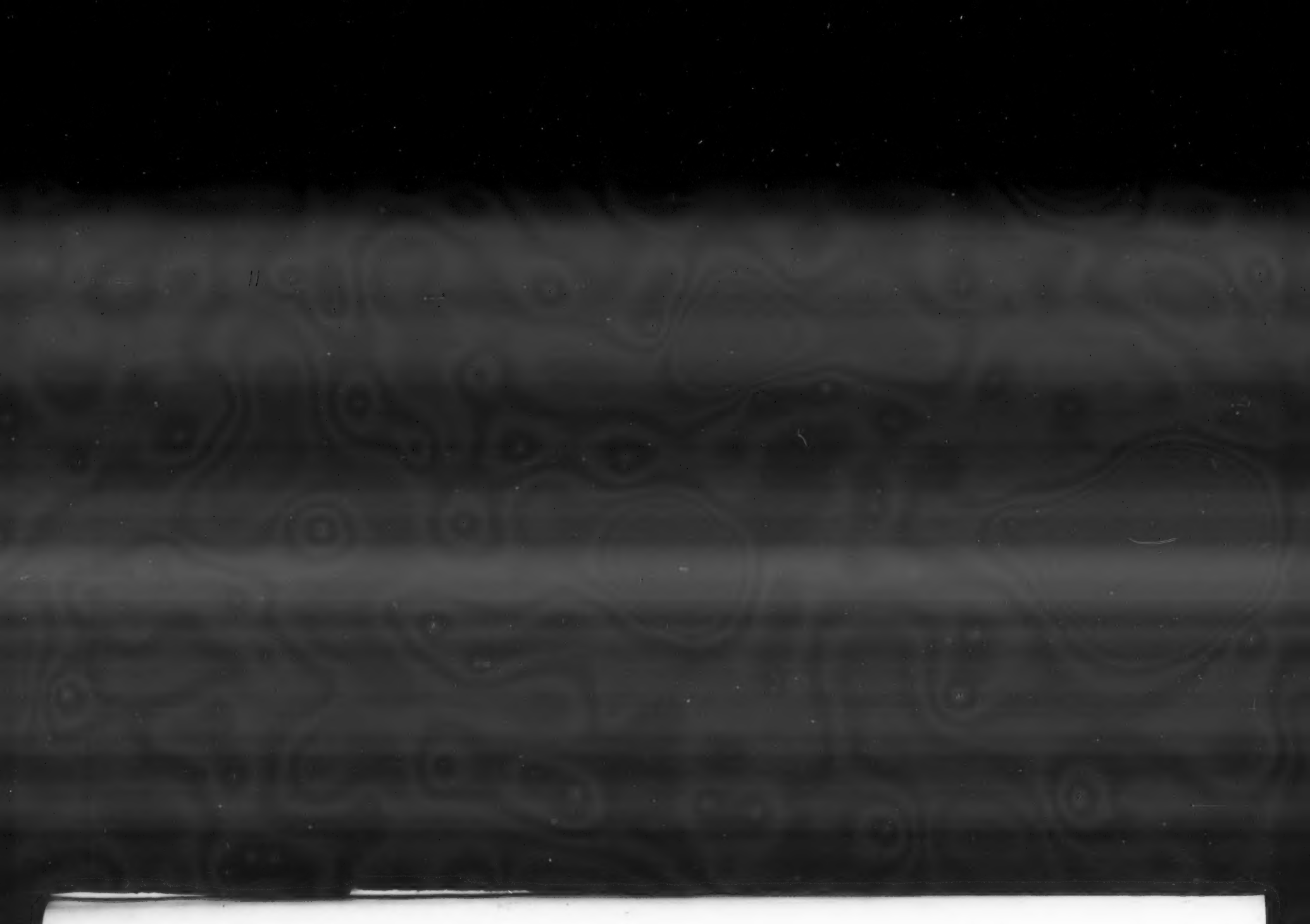
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